SCIENTIFIC AMERICAN

No. SUPPLEMENT 391

Scientific American Supplement, Vol. XV., No. 391. Scientific American, established 1845. | NEW YORK, JUNE 30, 1883. | Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

SWINGING THE GARABIT BRIDGE INTO POSITION.

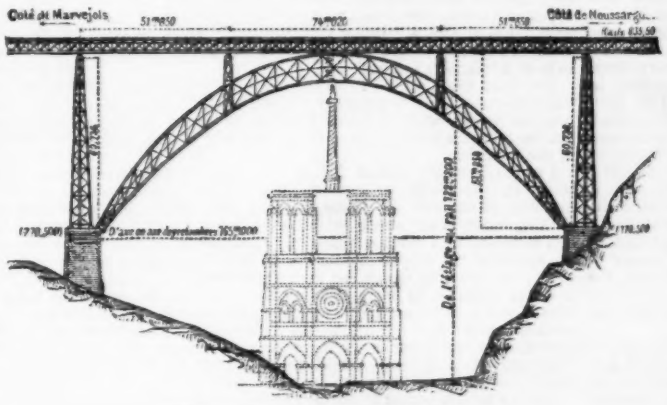
THE railroad from Marvejols to Neussargues, in course of construction for the Compagnie du Midi, after running over the tablelands between Aubrac and Margeride, meets, before reaching Saint Flour, a deep and narrow gorge, at the bottom of which flows the river Trueyre. This latter counts, among its other affluents, the Arcomie and the Mongon, whose mouths are opposite each other, and whose general direction is nearly that that is to be followed by the iron road. At first, then, it appeared most feasible to descend from the tablelands situated on the Marjevols side through the Arcomie valley, and to ascend through the Mongon valley to the opposite tableland, after traversing the Trueyre at a slight elevation.

Such a line had even been approved by a ministerial decision at the beginning of 1877, when Mr. Boyer, the new engineer of bridges and roadways in charge of this part of the road, was led, through a thorough examination of the ground, to a much bolder solution, and one that was greatly preferable and rendered possible by the immense resources that are furnished us by the most recent processes of the art of construction. This plan, studied under the direction of Engineer-in-Chief Bauby, was to have the roadway rest constantly on the tablelands, instead of traverse the small abrupt valleys, and to cross the Trueyre gorge at a considerable altitude.

The new studies were pursued with the greatest activity, and the work, which was begun at the end of the month of November, 1878, had been finished in the month of March, 1879, over a length of about 30 kilometers. The line was established over land that presented few obstacles, and the only difficulty was the crossing of the Trueyre valley over a length of 550 meters and at a maximum height of about 125 meters.

These figures alone give an idea of the importance that the work to be constructed was to possess. Nowhere as yet had a viaduct been constructed at so great an elevation, along with so wide spans as a necessary result thereof. The work, therefore, necessitated the services of some such young, active, and intelligent engineer as the author of this project, in order to bring the colossal affair that had been undertaken to a successful conclusion; and this gentleman succeeded in doing this only in employing known and approved processes.

The deepest part of the valley is to be crossed by a metallic arch of 165 meters span and 52 meters depth, analogous to the one employed for the first time by Mr. Eiffel in the Douro bridge in Portugal. Access to the top of this arch will be effected through metallic girders 52 to 55 meters in length, which are to rest upon metallic piers having a masonry foundation. The state engineers having recognized the necessity of adopting the Eiffel system of arch, judged it proper to commission that builder to execute the projected work.



THE GARABIT BRIDGE.

Our intention is not to give in this place a detailed description of the project and its execution, but only to make known to our readers the state of advancement of the work and the process employed for swinging the superstructure into position. The following is a brief description of the work as a whole:

The metallic piers are five in number, four of them being on the Marvejols side and one on the Neussargues. The masonry of piers 4 and 5 supports the imposts of the great arch. At each of its extremities the superstructure rests upon a small masonry viaduct which gives access to it. It has also as supporting points, in addition to the top of the arch, two framework piers that are mounted upon the latter.

The wide surfaces of the piers, that is to say, those that are transverse to the superstructure and which have to withstand the action of the wind, are constructed like lattice girders, the two members being connected by horizontal and diagonal cross-stays. Piers 4 and 5 are, exclusive of masonry, 61·16 meters in height. The width of the larger sides is 15 meters at the base and 5 at the apex, or a batter of 0·082 of a meter per meter. The narrow sides measure 7 meters at the base and 2·33 meters at the summit.

The superstructure consists essentially of two straight lattice girders 5·16 meters in height. The track is to be placed 1·66 meters beneath the upper chords, so that the cars may be prevented from running off the bridge in case of a derailment. Beneath the track there is to be a solid roadway of Zoré iron, which will give the superstructure great transverse rigidity. Between the lower plat-bands and the iron flooring there is to be a small service road provided with rails for the running of hand-cars.

Weight of the superstructure	1,350,000 kilogr.
Weight of the piers	650,000 "
Weight of the arch	1,200,000 "
Total weight of metallic portion	3,200,000 "

The total cost of the viaduct will amount to 3,100,000 francs, including masonry and excavations.

Execution of the Work.—Mr. Eiffel set himself promptly to work. The masonry portion was executed with much care, and with as great rapidity as the nature of the ground permitted, and it was soon possible to proceed with the metallic parts, which were pushed forward with remarkable dispatch. The putting together of these had scarcely been begun on the 1st of September, 1882, but by the 30th of April, 1883, all the piers, the Marvejols span, and the greater part of the Neussargues one had been constructed, so as to make it possible to soon proceed with the mounting of the large arch.

The iron piers were elevated by simple gins, which were

THE GARABIT BRIDGE OVER THE TRUEYRE, FRANCE.

raised higher and higher in measure as the work proceeded. When it is reflected that the height of one of the piles above ground exceeded 80 meters, that it was often necessary to fasten the gin guy-ropes in the very bed of the Trueyre, and that the length of these ropes reached several hundred meters, it will be seen that, although the process was in itself remarkable for its extreme simplicity, the maneuvers were none the less accompanied with considerable difficulty. This general character of simplicity, however, is found in all the other operations connected with this structure, and is the first thing that strikes the visitor who examines the gigantic undertaking.

Swinging the Superstructure into Position.—Upon each bank, the corresponding part of the viaduct was mounted upon platforms prepared for the purpose by Mr. Eiffel, and which were the same as those that he used with his Douro bridge.

Each apparatus consisted of a frame of plate and angle iron, which rested at the center upon an axis around which it could oscillate. On this frame there were two friction rollers, 0·5 m. in diameter and spaced 1·10 m. apart from axis to axis. Owing to the mobility of this arrangement, the two rollers always carried at the same time, whatever were the inflections that the bridge underwent, and whatever were the variations in the thickness of the bottom chords. Upon the axle of one of the rollers there was mounted a ratchet-wheel, which was actuated by a large wooden lever, whose length exceeded the height of the superstructure.

At those points where the girders exerted the greatest pressure the number of contacts was increased by employing a four-roller apparatus. This latter consisted of two two-roller apparatus analogous to the preceding, and capable of oscillating on a large frame which itself rested upon an axle at its center. Owing to these three articulations, the reaction was always distributed equally between the four rollers.

The apparatus were distributed beneath the girders in such a way as to correspond with each other, two by two, perpendicular to the axis of the viaduct. In order to secure uniformity in the maneuvers, the wooden levers were connected in pairs by bars, which were manned by workmen standing upon the superstructure. All these levers acted simultaneously and with a properly regulated stress, so that the bridge moved forward without tending to incline the piers. These apparatus had, in fact, the advantage of almost completely suppressing horizontal tractions and of forcing the vertical reaction to pass through the center of the bearing points. When the operation was finished, the girders were slightly raised by means of hydraulic jacks in order to remove the apparatus from beneath them and put in place the final bearings.

We were present at the placing of the Marvejols span, a portion of the bridge which is 285 meters in length and weighs 850 tons. The mass to be moved was great, but its weight scarcely exceeded 3,000 kilogrammes per running meter. The wooden levers were 7 meters in length, and the bars that united them in pairs were manned by from fifty to sixty persons. When these latter were ready to act, a signal man stationed in each group raised a flag. At the sound of a trumpet made by the director of the maneuvers, all the levers were simultaneously thrust forward and then brought to a vertical position. There were also men standing near the rollers in order to lift the clicks of the levers when they were pulled back, so as to put in position wedges for facilitating the passage of the joint covers of the bottom chords. When it became necessary to raise the superstructure, Tangye's hydraulic jacks were used, each being maneuvered by one man.

Each action of the levers caused the girders to move forward 10 to 12 and sometimes even 15 centimeters. The result was that, moving at the rate of 8 to 10 meters per hour, the entire span was crossed in six hours.

The rolling of the structure was very gentle, and one who was standing upon it as it moved forward could perceive no vibrations except those proceeding from the iron piers, which were felt to oscillate slightly.

At present the superstructure has reached pier 4, beyond which there will probably be but three panels. The same process will be used with the Neussargues span, and there will thus be in front of each abutment pier a projection of a dozen meters that will serve to support the voussoirs of the large arch during its construction. At its other extremities the superstructure will then be held by metallic cables attached to angle-irons riveted to the last panels and passing through apertures in the abutments, in which they will be securely anchored.—*Le Génie Civil.*

FORBES' RIGS FOR WAR-SHIPS, AS PRESENTED TO THE BOSTON BRANCH OF THE NAVAL INSTITUTE.

IN our SUPPLEMENT 382 we gave diagrams of Captain Forbes' rig for merchant steamers. Opposite are given outlines of his rig for war steamers. The author says: Since the completion of my rig for steamers, the model of which I have shown, I have received from the President of the Advisatory Board a tracing of the *Chicago*, 315 feet long, 48 beam, draught 19, mean. Displacement 4,450 tons. She is to have a covered deck. She is to mount on the spar-deck four 8-inch rifles, and one in the cabin, and nine 6-in. rifles on the gun-deck. She is to have a modified ram bow; also, no keel, but bilge keels, and to be bark rigged with a surface of "plain sails," not over 14,000 square feet. To be propelled by twin screws. She is to be unarmored, and is to be propelled at a maximum speed of 16 knots, and a sea going speed of 14.

The dimensions are subject to alteration. The above is an extract from a circular issued by the Board.

In the sketch sent to me the position of smoke stacks and masts is given. As customary, the engineers give less thought to the position of the masts than I think ought to be given. If economy in cruising is to be, as it ought to be, *the primary object*, next to *speed and armament*, a rig should be chosen that will give the ship good sailing power in moderate weather, and have it so arranged that there will be little top hamper to retard progress under steam, and at the same time be manageable by a few men in strong gales. There should be a fair amount of square sails, say one-half of the whole area; and the rest should be fore-and-aft sails, all coming down to, or very near to, the deck. The lower stay-sails may have bonnets, but none of the square sails are to have reefs. After naming these general considerations, I shall now proceed to describe my different rigs.

No. 1. To have four iron or steel masts; a foremast 75 feet from the stem with a square foresail to come on deck; a lower and one upper topsail, and a topgallant sail; these may be called topgallant-sail and royal, as I prefer to style them. They are all to be bent by the foot; the topsail comes down with the help of leaders or "jack-stays," as in the little model shown you, and it can be rolled up by very ordinary sailors or marines. The yard is supported by lifts, and by a wire tye attached to the mast-head and leading through the saddle of the topgallant-yard; the royal is parreled to this tye and these two upper yards come down, polacca fashion, and furl on the topsail-yard, as you have seen by the model. The lower yard is attached to the mast above the rigging by a swivel parrel and hangs to a crane-like fixture 8 or 10 feet above it. It will be seen that the shrouds supporting the mast below the lower yard, and those running up to a point below the topsail-yard, and the stays leading forward, give very firm support to the principal yards and sails; above the topsail-yard there is a space of mast, about 55 feet, having two backstays and a stay to support the strain of the two upper sails—the jib sets to the topmast stay—and, perhaps, should be called a topmast-staysail. It must be remembered that when the two upper sails are furled there will be little strain on the 55 feet in question.

The next mast, 75 feet abaft the foremast, I call the "middle-mast," for want of a better name. It carries before it three large staysails, one stows on deck and one of the others comes down to a point near the eyes of the lower rigging, where there should be, as in some merchant steamers recently seen, a sort of gridiron or footing where a few men can stand ready to furl sails. This place must not be considered a "top" where Gatling guns can operate, but simply a "crow's nest" or foothold. The other staysail stows within 18 feet of the deck. Abaft this mast are two staysails; the lower one comes to the deck to furl, and the upper one comes down to a point about 35 feet above deck, or as far as the main topmast-standing stay. Even modern sailors can stow it there without much difficulty, with the help of a "Jacob's ladder."

The third mast, which I call the main, is 75 feet abaft the "middle-mast," and is precisely similar to the foremast except the length, which is about five feet more, in order to get the topsail a little further out of the way of the smoke of the funnels.

I have placed the boilers further aft than in the sketch sent me; *principally*, to accommodate my sail power, *collaterally*, to shorten the distances from the cranks to the stuffing-boxes of the shafts, and to give a better gun-deck and berth-deck; I should place my reserve coal bunker in the center of the ship; I should like to place my engines between the two after masts, so as to have very short shafts, and less liability to have hot journals. I am quite aware that in going so far aft I am trenching on what is considered the accommodations for the officers. I have not gone into this very closely, deeming it of secondary importance to the efficiency of a fighting machine. Still I see no reason to doubt that there will be room enough for all.

All the motive power of the *Meteor* was between the main and mizzen-masts, and she had a berth-deck and gun-deck of about 160 feet fore-and-aft. The mizzen-mast is 112 feet long, and should step above the line of the shaft or shafts. It carries a good sized mizzen with a boom of 60 feet, a gaff topsail, which ought to be set from the deck instead of by hoops as shown, and there are two very useful staysails, one of which comes down to the deck, and one within 25 feet; perhaps the mizzen should set by a rail on the mast, or on a trysail-mast, so as to avoid the chafing of the paint on the mast by the hoops. So much for No. 1, which I believe to be the best of the plans. I recommend narrow channels high up, and a guard of stout timber all round above the ports, so that in running alongside nothing shall fetch up.

No. 2. Has the smoke stacks not in the position where placed on the sketch of the Board, and it has less canvas than No. 1. The masts are to be of steel or iron; the general plan of the square rig masts is the same. I consider the smoke stacks too far forward, involving very long shafts, and a loss of berth-deck accommodation, both of which I deem important.

No. 3. Is supposed also to be rigged with iron lower masts, the two forward ones about 110 feet long; the motive power is supposed to be as placed on the sketch of the Board; the pole-masts fidded abaft carry only the two upper sails. The topsail-yard is to hang to a projection of the lower mast through the cap, assisted by a wire rope leading to the mast-head. Supposing that it be desirable to send down the two upper yards and sails, and to house the pole-masts; the topsail-yard, which is 67 feet long, without the sail, must depend on its parrel and on the mast-head crane to steady it, with, perhaps, 8 or 10 feet of the pole-mast remaining above the cap, and the whole dependent on the mast rope. But, with the upper yards down, it will seldom be expedient to house the poles.

If a ship of war should ever again be called to pass such forts as existed at Mobile and on the Mississippi and at Fort Fisher, all the yards would come down and the poles be struck, as on sketch 4, still leaving *seven* effective fore-and-aft sails in readiness for use, and two gaff-topsails. This plan has two square-rig masts about 100 feet apart, and two fore-and-aft masts about 53 feet apart, and these carry each a large gaff-sail and a gaff-topsail; these sails at first sight appear large, but the hoist is only about 60 feet, and the boom of the after one is only 50 feet, and may be compared to the mainsail of a pilot boat. If the eye only is to be consulted, this rig may be considered the best of the lot. Its principal defect, as in No. 2, lies in the fact that the two upper yards cannot come down snug to the topsail-yard, as in No. 1, and it will be well to have the topgallant-sail, rigged as usual, to clew up and furl, and bring the royal yard down and becket it to the topgallant-yard as was generally done in the early part of this century. In this plan the topsails and the foresail come *down*, the former to furl on the lower yard, and the latter to the deck. This plan contains about 20,480 square feet of canvas.

No. 4. This plan has been devised to suit the position of the motive power and the masts, as indicated in the tracing of the Board. It spreads over 14,800 square feet of plain sail, and still may be considered a mere jury-rig for a cruiser. The mizzen-mast, which is about 80 feet from the main, looks as if it belonged to some other craft.

If, in conformity with the limit of 14,000 square feet named in the circular of the Board, we reduce this sketch, by the removal of the three square sails on the mainmast, containing 2,880 feet, we come down to a *strictly jury-rig*, only fit for strong gales; still, it is a good rig as compared to the usual rig of our cruising ships, where the topmasts cannot be housed without impairing the sailing qualities of the ship in a great measure; as a general rule I am opposed to the large sheets of canvas exposed in such ships as the *Wabash* and *Minnesota*.

No. 5. Has the smoke stacks placed as in the sketch of the *Chicago;* the two square-rigged masts are similar to the others, but spread slightly less canvas, and the two after fore-and-aft-rigged masts spread a little more than No. 3; a change which I believe to be desirable, looking purely to the working of the ship under sail.

In all the plans I have made there is very little *reefing* to do; none to the square sails, and, excepting in the two after sails of No. 3, none in the fore-and-aft sails; but there are bonnets to be removed occasionally in very severe weather.

While I admit that my rigs are more necessary for short-handed ships—merchant ships—than for war ships, it is mainly because there are many more of the former than of the latter, and not because labor-saving devices are not equally important *in war time for war ships*. You all will recognize the fact that in an old style man-of-war it requires a very small sick list to make a ship short-handed. I call to mind an illustration of what I say: When, in 1850, after a typhoon, a ship of my building, to my consignment, was reported outside dismasted, I applied to the commanding officer of the United States squadron, consisting of the *Plymouth* and the *Dolphin*, to send one of them in search of her, and was informed that the latter, a brig of about 300 tons, had a dozen men on the sick list and could not be sent, and so I was obliged to charter a steamer at a cost of $500, more or less, per day, and I sent "Jimmy" Watkins in search of the missing ship. On his way he fell in with the British brig-of-war *Wanderer*, Sir John Hay commanding, who was in chase of several pirate junks in a calm. Speaking her, Watkins was requested to tow the *Wanderer* into action; forgetting all about the wrecked ship, and my $500 per diem, he complied, and soon had the brig nearly in position, when the pirates began to fire on the unarmed steamer; little did Watkins care for that, but the captain of the steamer began to inquire if he was chartered to go into battle, and whether his insurance would be good; he came to the conclusion that the "better part of valor is discretion," cut his hawser, and left the *Wanderer* becalmed, while the junks plied their sweeps and got out of range. Then spoke Hay, and requested Watkins to go to Hong Kong, some fifty miles away, and inform the British admiral of the state of things, and ask him to send out a force of boats to attend to the pirates. Of course Watkins went, and before many hours came back towing half a dozen armed boats full of marines and seamen. In the mean time the pirates had come to anchor in a bay where they had a regular shipyard, an arsenal, etc., and the *Wanderer* kept watch of them; on the arrival of the flotilla they pulled in for the enemy, Watkins in the advance as a volunteer; the junks were quickly deserted by their crews, many taking to the water, where many were killed. The vessels and warlike stores were burned, and all the boats returned to Hong Kong full of grog and glory in tow of my chartered steamer. The lost vessel (*The Coquette*) and all on board were never heard of.

After a time the officers of the English squadron sent to me from England a splendid sword for Watkins, in recognition of his gallantry in assisting Sir John Hay at the cost of the charterers of the steamer. These facts are stated after thirty and odd years, and may be improved upon by Sir John if he lives, or by Captain Jamieson, of the P. and O. seamer *Canton*, which I chartered. After my dull yarn about sticks, sails, fids, etc., I trust you will forgive this digression.

"Jimmy" Watkins was a considerable time in my service, and, while I fully approved of his doings, I sometimes thought that that sword ought to have been inherited by myself when he wound up his mortal coil.

No. 6. Shows where the motive power and the sail power suit me best.

R. B. FORBES.

March 31, 1883.

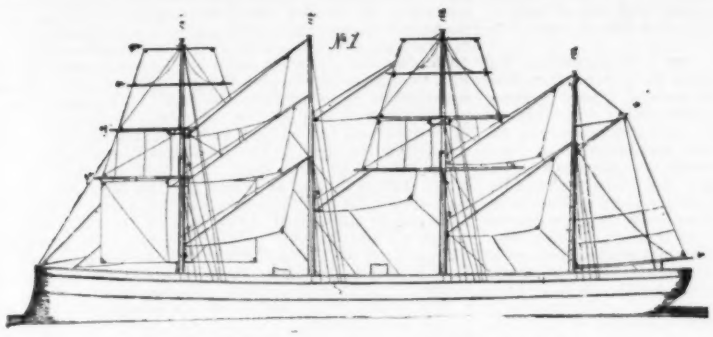
THE USE OF COAL GAS AS A MEANS OF VENTILATION.

By NORTON H. HUMPHRYS.

IT is easy enough to understand that a very slight mechanical force, applied by the medium of a fan or "blower," is sufficient to impel a quantity of air through an ordinary building, and out at the apertures provided for the purpose; but when air is made to circulate by the action of heat, the cause of motion is not so obvious. It is well known that heated air ascends; but with what velocity it ascends, and the quantity of air that is thus put into circulation in proportion to the quantity of heat generated, is by no means generally understood.

A gas flame can be used as a motive power for the work of ventilation, because it is a source of heat; and the efficiency of gas or any other source of heat for purposes of ventilation will vary with the quantity of heat produced. Given a room of constant size, the velocity of the air through the room will, neglecting for the moment the loss of velocity by friction, be in some proportion to the quantity of heat imparted to the air. The means by which this velocity can be calculated from the temperatures at the inlet and the outlet are very simple. Let us suppose a room to be 10 feet in height, and the external air to be 32° F., while the average temperature of the internal air is 62° F. The force which causes the air to move out of the apartment is due to the difference in weight between a column of air 10 feet high at 32° and at 62° respectively. This difference will be found, by the law of the expansion of air by heat, to be equivalent to about 0·58 foot of air—a column of air 10 feet high at a temperature of 62° is equal in weight to one of 9·42 feet in height at 32°. Borrowing an expression used in hydraulics, we may say that the air escapes under a "head" of 0·58 foot; and the velocity is, $\sqrt{\text{head}} \times 8$, in this case $\sqrt{0{\cdot}58} \times 8 = 6{\cdot}1$ feet per second. But suppose the difference between the internal and the external temperature to be doubled—that the average internal temperature is 92°, the outlet remaining at 32°. It will be found that the "head" under these circumstances is 1·00 feet of air, and the velocity $\sqrt{1{\cdot}00} \times 8 = 8{\cdot}2$ feet per second. Although the quantity of heat has been doubled, the velocity of the air is increased only to the extent of one-third; and this illustrates the fact that the best ventilating results are obtained by heating a large body of air to a small extent. The importance of this will be seen in the subsequent examples. This calculation affords us a simple means of estimating the ventilating efficiency of the arrangement described at the commencement of this series of articles. The temperature at the outlet will represent the average temperature of the air in the tube above the gas jet; and the distance from the gas jet to the top of the tube will give the height, from which the "head" and velocity can be calculated, as just shown. The horizontal portions of the tube and the vertical portion *below* the gas jet are of no use, and do not enter into the calculation; unless they are of such a length that it is necessary to take into consideration the retarding effects of friction.

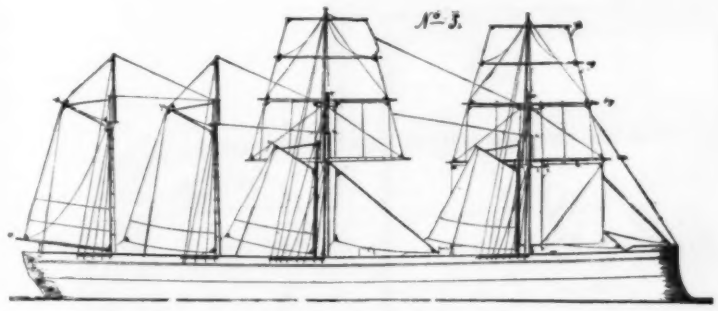
This theoretical velocity cannot be obtained in practice. In the first place, the "head" will be divided into two; for



APPROXIMATE AREA OF SAILS IN SQUARE FEET.

Six square sails, 8,910; fore-sail, 2,800; seven stay-sails, 5,950; mizzen and gaff top-sails, 1,630; head sails, 800. Total, 20,090.

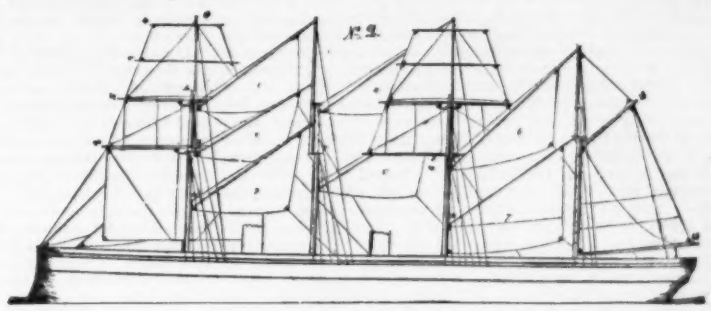
NOTE.—The masts are iron or steel, all in one. Stay-sails are all alike. Fore-sail comes to the deck. Top-sails come to lower yards. Topgallant-sails and royal come to the top-sail yard to furl. The three lower stay-sails come down to the deck. The three upper to B B B. The middle one forward to C.



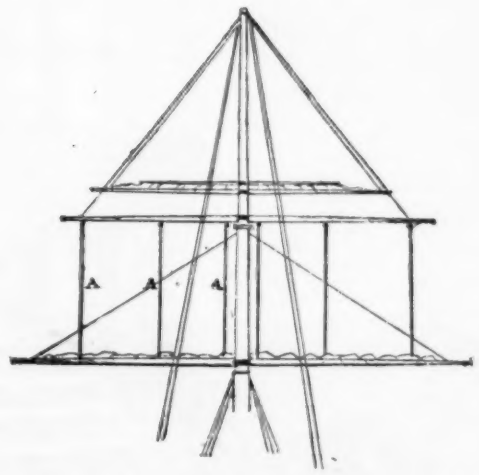
AREA OF PLAIN SAIL IN SQUARE FEET.

Fore-sail, 2,960; six square sails, 7,182; two spencers, 2,840; two after gaff-sails, 4,210; two gaff-top-sails, 920; jib, 850; main stay-sail, 879; fore stay-sail, 640. Total, 20,481.

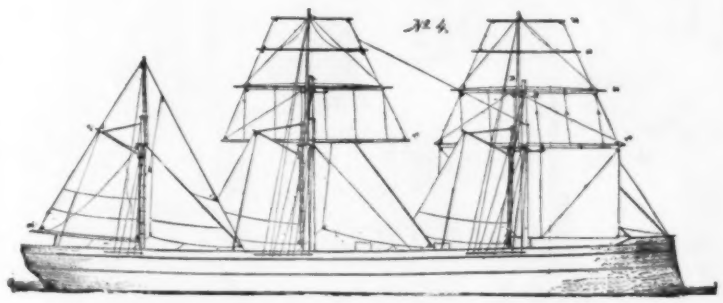
1, 1 are jack stays to lead the sails down by. 2, 2, Tricing tackle to set sails. 3, 3, Club yards. 4, 4, Cranes to support yards. 5, 5, Top-sail-yard tye. Six square sails are bent by the foot. Fore-sail comes on deck.



Fore-sail comes to deck. Top-sails come to lower yard to be furled. Topgallant-sail clews up to A. Royal beckets to topgallant yard. Stay-sail 1 comes down to B. Stay-sail 2 comes down to C. Stay-sail 3 comes down to deck. Stay-sail 4 comes down to D. Stay-sail 5 comes down to deck. Stay sail 6 comes down to E. Stay-sail 7 comes down to deck.



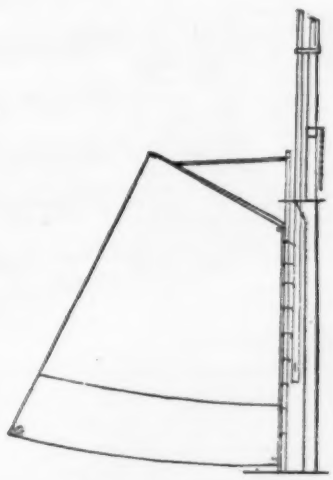
This represents a top-sail, topgallant-sail, and royal furled. A, A are the tricing tackles to top-sail.



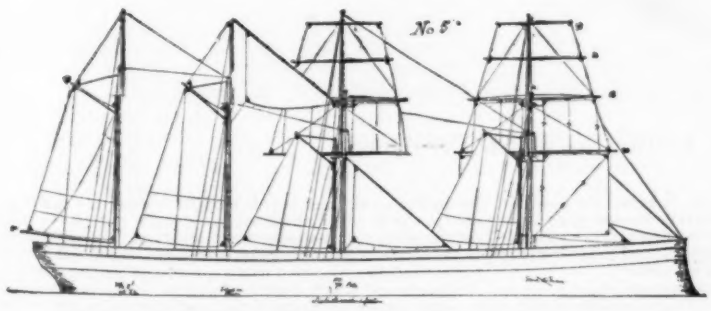
APPROXIMATE AREA OF SAILS IN SQUARE FEET.

Six square sails, 6,000; fore-sails, 2,664; two spencers, 2,680; one mizzen, 1,770; gaff top-sail, 40[illegible]; fore-top-mast stay-sail, 830. Plain sails, 14,344. Mizzen stay-sail, 800; mizzen top-sail, 570; main stay sail, 1,250; fore stay-sail, 660. Total, 17,624.

Fore-sail comes to the deck. Top-sail comes to lower yard, guided by jack-stays, A A. Topgallant sail clews up and furls at B. Royal beckets to topgallant yard. When the topmast poles are housed and the yards are down, eight useful sails can be set. The smokestacks are placed as in the plan of Chicago received from the Board. See the engraving at side for a mast stripped for battle.



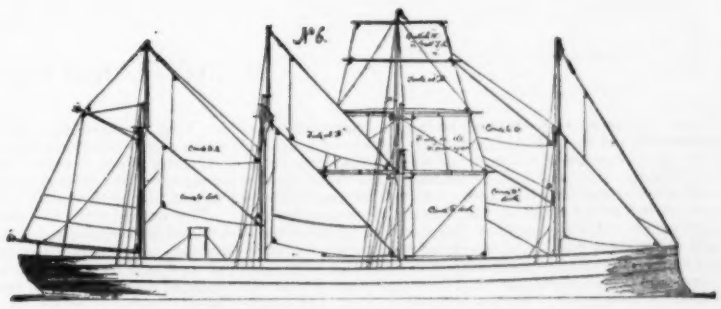
A MAST IN FIGHTING TRIM.



APPROXIMATE AREA OF SAILS IN SQUARE FEET.

Six square sails, 7,070; fore-sail, 2,960; two after gaff-sails, 4,700; gaff top-sails, 900; two spencers, 3,460; stay-sails and head-sails, 3,000. Total, 22,090. Deduct light sails, 3,900, leaves plain sail, 18,190.

Fore-sail comes on deck. Top-sail comes to lower yard. Topgallant-sail clews up and furls at A. Royal beckets to the topgallant yard. B, B are jack-stays to guide sails down.



AREA OF SAILS IN SQUARE FEET.

Three square sails, 4,380; fore-sail, 3,200; mizzen and gaff top-sail, 3,000; mizzen top-stay-sail, 940; mizzen stay-sail, 770; main lower sail, 1,710; main upper sail, 1,065; two stay-sails, 1,600; head sails, 1,985. Total, 18,650.

CAPT. R. B. FORBES' RIGS FOR WAR SHIPS.—(See page 6232.)

it will have to draw the incoming air into the room through the apertures provided for the purpose, and also to expel the used air through the outlets. Then there is the loss due to "coefficients of discharge," varying with the shape of the different openings through which the air has to pass. It is found in practice that these several sources of loss reduce the actual velocity at the outlet to one-fourth or one-fifth of that ascertained by theory; and this when every care has been taken to provide proper apertures of sufficient area, both for the incoming and outgoing air. Taking a factor of $\frac{1}{4}$ as the practical efficiency, it will be found that in a room 10 feet square and 10 feet in height, heated to 62° while the external air is at 32°, and having ventilating apertures in the floor and ceiling respectively of one square foot in area, 4,320 cubic feet of air per hour will pass through—a sufficient supply of air for five or six persons. The amount of heat required to raise this quantity of air as required—30° in temperature—is very trifling; 4,320 cubic feet of air at 62° weigh nearly 330 pounds; and since the specific heat of air is 0·238, it follows that the amount of heat required for this purpose is 2,350 units.

Thus it can be easily proved on paper that ventilation may be effected by an insignificant expenditure of heat, and without mechanical appliances or any special apparatus. But here the practical difficulties come in. This plan of ventilation—simple apertures—is rendered impracticable by changes in the direction of the wind and in atmospheric temperature. Arrangements of the nature of baffle plates or light flap valves may be adopted; and all sorts of contrivances of this kind have been introduced for the purpose of preventing the action of the wind from interfering with the process of ventilation. But, at best, where used with simple apertures, these have only been partly successful; and this plan of ventilating may be discarded as impracticable, although it is possible that, under some circumstances—as, for instance, a building in a very sheltered position—it may be applied with advantage. The most successful schemes of ventilation in actual use for large buildings, etc., include the use of outlet apertures of such a size that the air passes through them at a brisk rate; thus creating a current that is capable of rising superior to the action of the wind. To secure this result without mechanical apparatus, the use of shafts, or large tubes of some considerable length, is necessary; the inlet apertures being so arranged and of such an area as to reduce as low as possible the loss of "head" by friction.

If cold air is admitted into a room, it is imperative that the direction of the air current must be upward, from floor to ceiling. But if the air is first warmed, it may be downward—the air may be admitted at the ceiling and taken out at the floor level. Each of these plans possesses some advantages and disadvantages. The admittance of the fresh air at or near the floor line enables the occupants to have the benefit of perfectly pure air; but it also brings with it a liability to cold draughts. If admitted at the floor line, it reduces the temperature of the floor; and thus, for reasons that are explained in my remarks on heating, creates a sense of chilliness and discomfort. Many of the disadvantages of this system of ventilating have been obviated by the simple plan of admitting the fresh air at an elevation of (say) 4 feet above, instead of at the floor line; and by providing means for warming the air in cold weather. The plan of admitting cold air at the top of a building or room, and withdrawing it at the floor line, usually fails, because the cold air, being denser than that in the room, falls at once to the floor, and thus direct currents from the inlet to the outlet are created; but if the incoming air be first warmed to the temperature of that in the room, this does not occur.

The objection to the downward current is that it cannot be used with naked lights, when the lights are above the occupants, as is usually the case; for the lights get the fresh air first, and by the time it reaches the occupants it has been charged with products of combustion. Apparatus has lately been introduced which successfully overcomes this objection. The gaslights are inclosed in a tube, which constitutes the outlet shaft (a glazed pane being inserted in order to allow the light to show into the room), and this outlet shaft is wholly or partly surrounded by a larger shaft, which admits the air into the room. The fresh air is admitted at the bottom of the exterior shaft (which has no communication with the interior shaft) by suitable tubes or apertures communicating with the external air. In passing up this shaft, it takes up heat by contact with the outside surface of the interior shaft—that is to say, the portion of it that is above the gaslights—and is thus raised in temperature without losing its original purity before passing into the room. Since it is the space above the gaslights that affords the useful warming effect, it is evident that in using the same gas jet for lighting purposes there is a loss of heating power. For, in order to be effective the gas lights must be at some considerable elevation from the floor. It is therefore open to consideration whether it is not advisable to adopt some other apparatus for lighting, and to employ this for heating and ventilating only, by the use of small subsidiary gas jets at the base of the outlet shaft. The inlet to the interior or outlet shaft is situated at or near the floor line, and the shaft is continued out into the open air or into a main outlet shaft. Thus the air is admitted at the base of the exterior shaft, passes up and out into the room near the ceiling, where it diffuses itself equally, and gradually descending to the floor, finds its way to the outlet shaft, in which the gas jets are contained, and thence out into the open air.

The source of the action of this apparatus—its motive power, so to speak—is the heat given off by the gas in the act of combustion. Part of this heat is used for warming the incoming air, and part is used for heating the outlet air and products of combustion; the former quantity is used for warming, and the latter for ventilation. The vital point in the action of this apparatus is the size and length of the outlet shaft in proportion to the quantity of gas burned in it. And if the gas is to be used for lighting, we are handicapped to some extent as to the velocity of the air in the outlet shaft. Too rapid a velocity will cause the lights to flicker. Let us assume that we require to pass, by means of an apparatus of this kind, 10,000 cubic feet of air per hour through an apartment, that the air is admitted at 32°, and must be raised in the outlet shaft to a temperature of 92° F. The quantity of heat required for this purpose will be $10,000 \times (92° - 32°) \div 55·2$ (the latter quantity being the number of cubic feet of air that one unit of heat will raise in temperature to the extent of 1°) = 10,870 units. The quantity of gas required to produce this amount of heat is rather less than 16 cubic feet; accepting the usual factor of 700 units per cubic foot. For the requirements of 14 or 15 persons, 10,000 cubic feet of air would suffice; and after allowing for the transpiration of air through the walls of the room, we

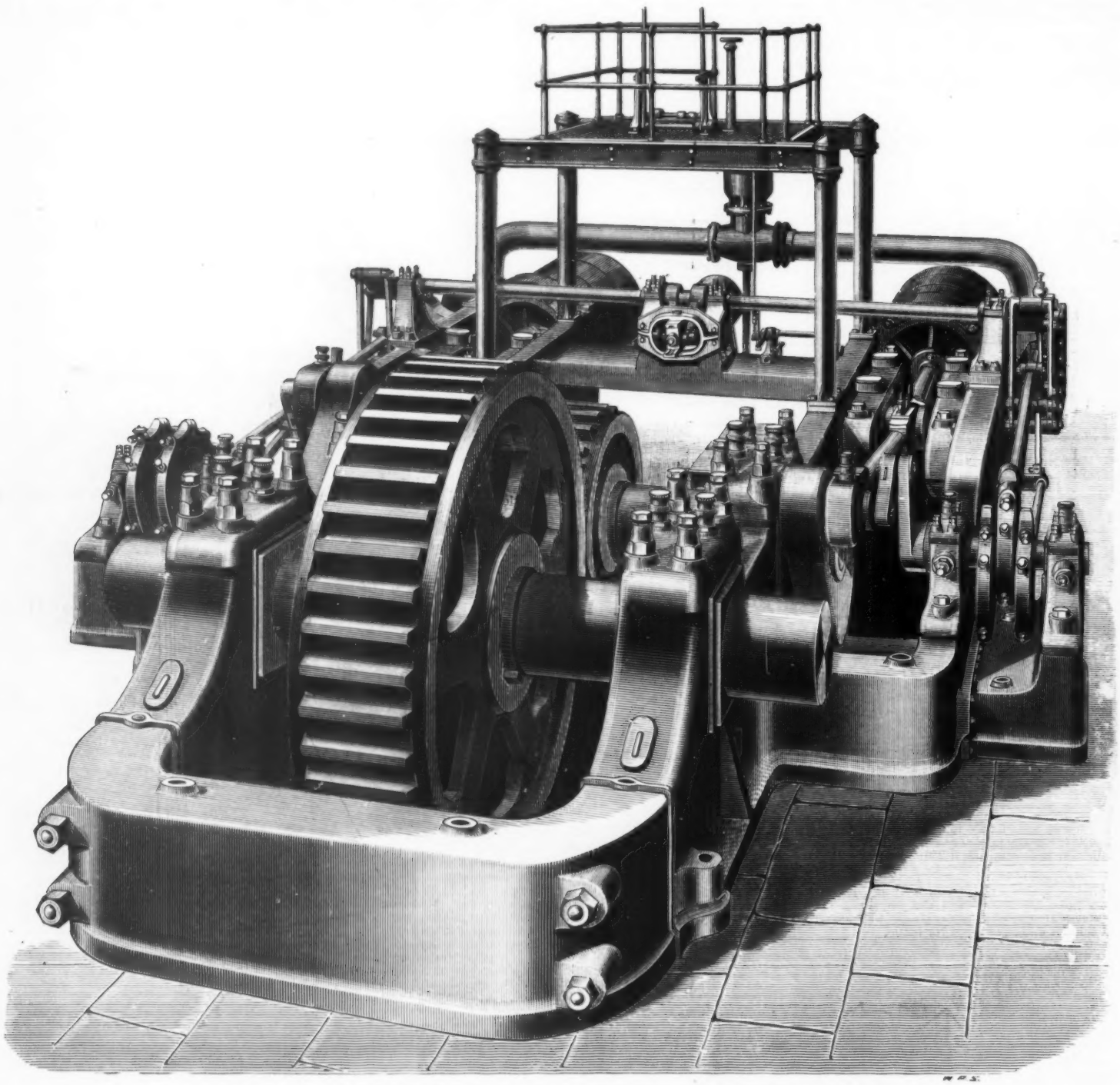


FIG. 1.—IMPROVED REVERSING COGGING MILL ENGINES.

may say that it is possible to ventilate an apartment by the very low expenditure of 1 cubic foot of gas per hour for each occupant.

We may glance, in passing, at the effect of the length of the chimney or outlet shaft. It will be seen by the previous example, that the "head," or pressure, will vary as the length. Thus, a 10 foot shaft will give us 0·58 foot "head;" a 20-foot shaft twice as much, or 1·16 foot; 30 feet, three times as much; and so on. According to the rule $\sqrt{\text{head}} \times 8 = \text{velocity}$, the theoretical velocity of the current, and therefore the quantity of air removed from the apartment, will be proportionate to the square root of the length. If we lengthen the shaft fourfold, we increase the velocity twofold without affecting the consumption of gas. This shows that the outlet shaft should be as long in perpendicular height as circumstances will permit. The lower part of it—that inclosed by the exterior shaft—should be made of good heat conducting material; while the portion continued above it should be of non-conducting material. If the whole were of thin sheet iron, for example, a considerable loss of heat by radiation from the upper part of the shaft would obtain; and such loss of heat means loss of velocity, and therefore loss of practical effect.

It must be remembered that the theoretical velocity will be divided into two. The air has to be set in motion at the inlet, and this velocity will be practically lost in its passage through the room, and therefore will have to be got up again at the outlet shaft. There is also the loss from other causes, as already mentioned. We have seen that the theoretical velocity for an increase of temperature of 60° is, in the case of a shaft 10 feet in length, 8·2 feet per second. Dividing this by the factor of practical efficiency, 0·2, we get 1·6 feet per second. The effect of increasing the length to 20 feet would, according to the preceding calculations, increase the velocity to 2·3 feet per second; a length of 30 feet would give 2·8 feet per second; and 40 feet, 3·2 feet. It should be mentioned that this factor of practical efficiency is sufficient to include a loss of "head" due to the use of a cowl or wind protector at the top of the shaft; for it is quite practicable to use such appliances at the top of a shaft, though they do not work well with simple apertures. The velocity being known, it is an easy matter to calculate the size of the shafts required to effect the foregoing conditions. In each case they will be dependent upon the perpendicular height. Taking the outlet shaft first, it will be found that for the shortest length (10 feet) a sectional area of rather less than 1·75 square feet will be required—say 16 inches square for a square shaft, or 19 inches in diameter for a round shaft. For the longest length, half this area would suffice—say 11¼ inches in the side, or 13 inches in diameter. A little consideration will show that the inlet or exterior shaft must also be in the same proportions with respect to its height.

There is the question of heating the air, in its passage up the external shaft, by means of the heat radiated and conducted from the external surface of the internal outlet shaft; but this is a question of constructive detail that need not be followed out here. In order, however, to act efficiently, this must be capable of regulation. In warm weather it will not be necessary to heat the air at all; and the colder the weather the greater the quantity of heat that will be required for this purpose. Perhaps the best means of securing this result would be to provide some means of regulating the level at which the fresh air was admitted to the inlet shaft, by means of apertures, one at the base and one at the top of the shaft. In cold weather, the top aperture must be entirely closed, and all the air admitted at the bottom; while in warm weather the whole of the air might be admitted at the top of the shaft.—*Journal of Gas Lighting.*

ROLLING MILL ENGINES.

WE illustrate two pairs of engines constructed by Messrs. Davey Brothers, Limited, of the Park Iron Works, Sheffield, for the rail mill of the Tredegar Bessemer Works. Fig. 1, opposite, shows the reversing cogging mill engines, and Fig. 2 the rail mill engines. In the former the cylinders, which are overhung, are forty inches in diameter and five feet stroke, and are fitted with balance slide valves worked, through reversing links of the Allan type, by eccentrics fitted to separate shafts and driven by drag links from the main cranks. The reversing is effected by a steam cylinder fitted with suitable controlling gear, so arranged as to dispense with the usual oil cataract. All the starting handles are brought to an elevated platform erected over the center of the engine, so that the man in charge has a complete view both of the engine and of the rolls.

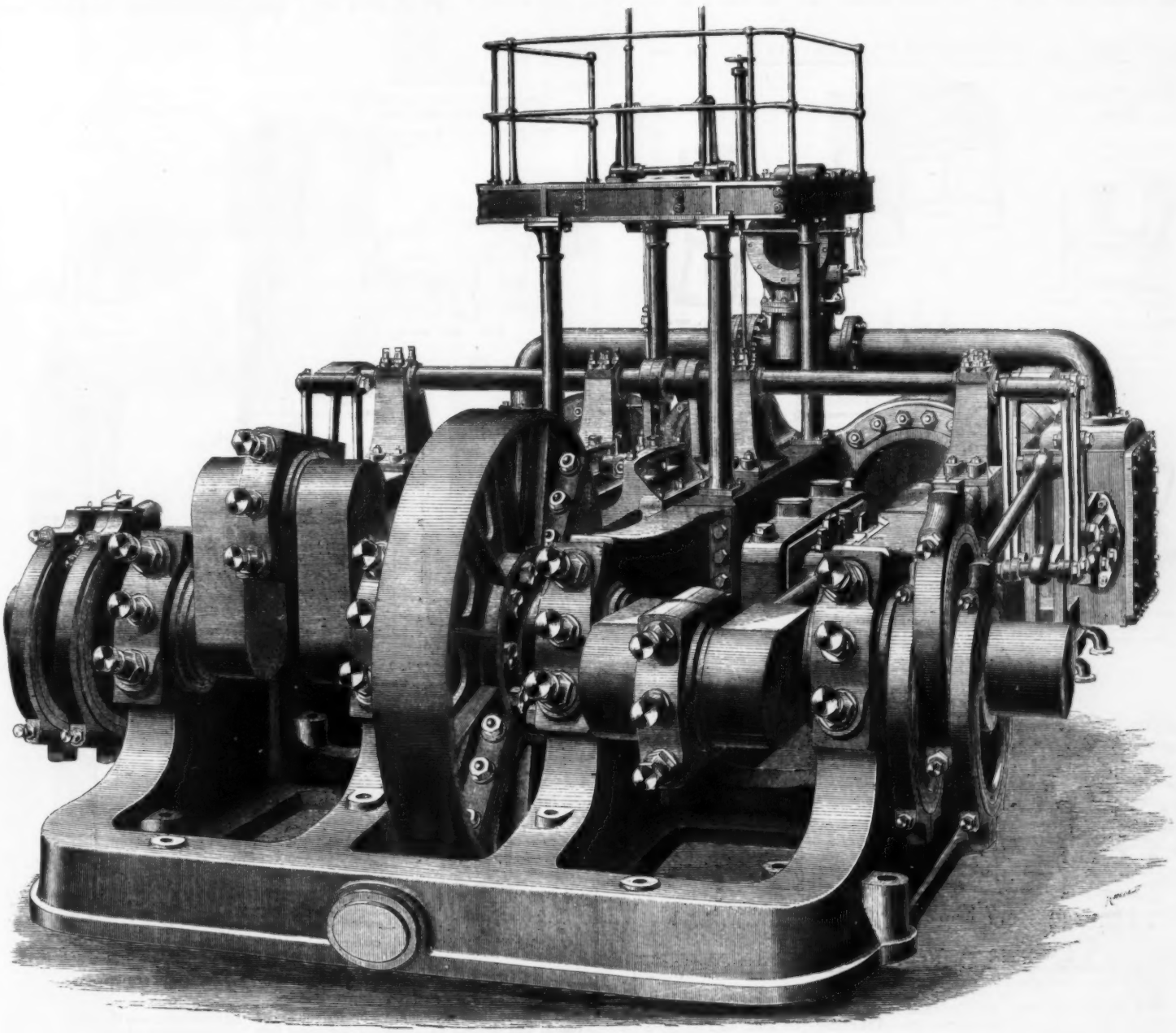


FIG. 2.—IMPROVED RAIL MILL ENGINES.

The cranks are of cast steel and have the counter-weights cast on. The crankshaft is of best wrought scrap iron, 16 inches in diameter in the journals and 20 inches in the middle. The second motion shaft is also best wrought scrap iron, 20 inches in diameter in the bearings and 24 inches in the middle. The spur gearing has a ratio of about two to one. It is eight inches pitch and twenty-four inches wide at the points of the teeth. The total weight of the engines is about 140 tons.

The engines designed for driving the finishing rolls have cylinders 48 inches in diameter, and 4 feet 6 inches stroke. They are overhung and fitted with balanced slide valves driven by eccentrics through reversing links of the Allan type. The reversing is effected, as in the previous case, by a steam cylinder fitted with suitable controlling gear, so arranged as to dispense with the usual oil cataract.

The crankshaft is 18 inches in diameter in the journals; its extreme length is 20 feet, and its weight upward of 13 tons. It is made in halves, bolted together in the center, the flanges being used for carrying the balance disk. The height from the foundation to the center of the crankshaft is four feet, and the total weight of the engines about 150 tons.

We may state that a modern rail plant, consisting of cogging, roughing, and finishing engines and mills, will turn out 3,000 tons of rails per week with ease, while formerly 700 to 800 tons was considered a splendid week's work.—*Engineering.*

A PAPER STEAM LAUNCH.

The Westinghouse Machine Company, of Pittsburg, is having made at Lansingburg, New York, a steam launch, length of keel 20 feet; breadth of beam, 5 feet; depth of hold, 3 feet; length over all, 24 feet; draught of screw, 24 inches; length of shaft, 8 feet; weight without machinery, 1,000 pounds; seating capacity, 25 persons; carrying capacity, 3 tons. The craft is built in two sections and jointed on the keel. The sheathing is a solid body of paper, three-eighths of an inch thick, a quarter of an inch thicker than on racing boats. A bullet from a revolver fired at the sheathing, at a distance of four feet, neither penetrated nor made an abrasion. Experiments have shown it is impossible to soak or soften the hull or increase the weight by the contact of water. A paper vessel of a thickness corresponding with the hull of the launch, prepared without paint or outside protection, was placed in the water last October and remained eight months. It shows no sign of moisture inside nor evidence of disintegration. The motive power of the craft will be a Westinghouse engine of six horse power, 2,000 revolutions a minute. The engine and machinery will be placed in the boat at an early day, when a trial trip will be made.

IT has been proved by numerous experiments that flour cannot bear the action of the sun, even when not exposed directly to its rays. When flour is exposed to the heat of the sun, an alteration takes place in the gluten similar to that produced by the heating of the stones. For this reason it is advisable that the transportation of flour should take place, if possible, on cool days or by night, as well as that flour should be stored in a cool place.

SKETCHES FROM THE FURNITURE EXHIBITION, LONDON.

THE furniture represented on the engravings below is principally in the manner of the Queen Anne and Georgian periods, some pieces being exact reproductions of antique models, while in the case of the serpentine front sideboard, and the tall clock, the old examples themselves are exhibited, though with regard to the latter some necessary restoration has been effected. The sofa and heart-shaped chair with stuffed back are types of the graceful thinly stuffed upholstery to which Heppelwhite has given his name. The sofa is temporarily covered in plain silk of tender apple green shade, characteristic of the style, but when permanently finished should have a double row of brass nails. The clock is in the manner of Chippendale, very graceful in detail, and is fitted with a light bell chime movement. The enrichment upon the door is freely carved in low relief. Of the two writing cabinets, that in the style of Sheraton is of satinwood inlaid with festoons. The table, which is hinged, forming a writing flap, is supported by thinned legs and stretcher, and the upper part is inclosed by glass doors latticed, the cornice being surmounted by shaped pediment with vase. The other writing cabinet is of English walnut, inlaid with bandings of plainer wood. It also has the hinged flap and cabinet for the display of china, with canted pilasters fluted at the corners. Here, however, the center is suited for a hall or library, the frame being of dark oak and the covering of rich brown morocco, finished with bronzed nails and a fringe of leather. The wicker seat chair is from an old example from one of our baronial halls; that with rush seat, which is of later date, is also from an old model. It may be noted that many of these old types of chairs can only now be used in their reproductions, the originals being for the most part unsafe or entirely worm-eaten.—*Building News.*

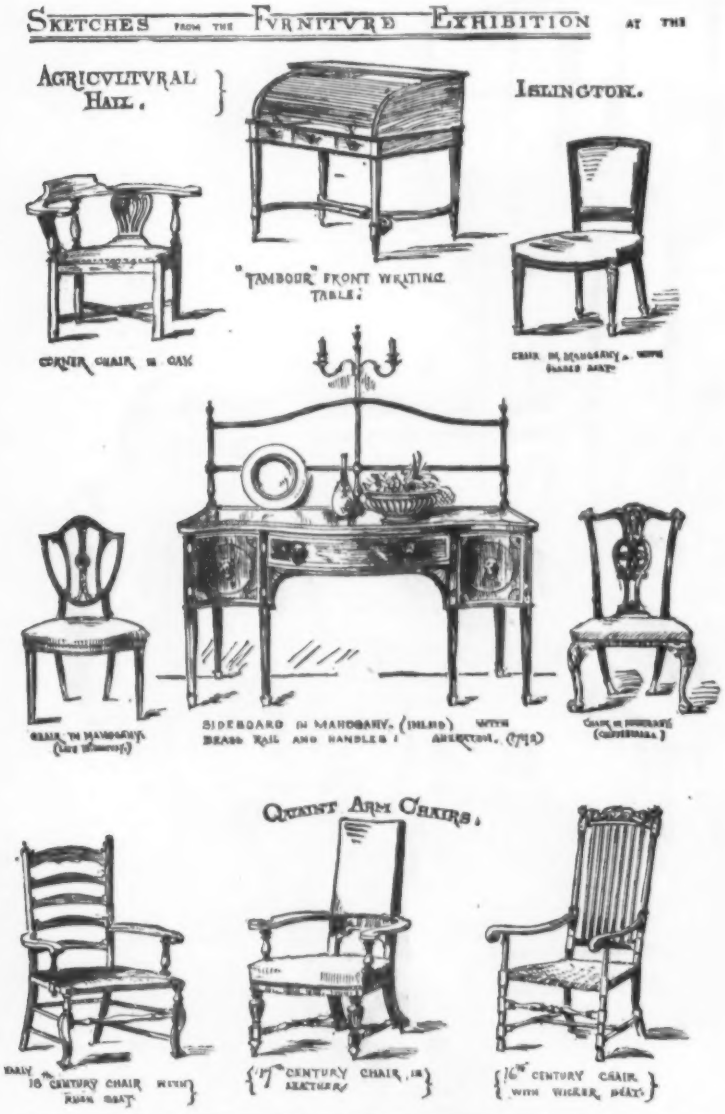
SKETCHES OF FURNITURE FROM THE FURNITURE EXHIBITION.

THE engravings opposite give examples shown at the Agricultural Hall, Islington, and their variety serves to indicate the comprehensive character of the Furniture Exhibition, where designs of an essentially nineteenth century pattern are represented by choice and elaborately finished pieces placed side by side with specimens, either of genuine old English make, or of carefully executed copies of ancient examples. Of this latter class, we have noted several satisfactory efforts in the collection shown by Messrs. Conrath & Sons, from whose stall we have sketched a very handy cabinet chest of drawers, made in dark mahogany, with inlay decorations in colored woods, simply and honestly treated.

Mr. John Eyles exhibits some good satinwood copies of low, the latter making a good base of rigid pattern. An open grate occurs on the other side, but our sketch gives the more satisfactory view.—*Building News.*

SHERATON FURNITURE.

WE give on next page examples designed by Sheraton, whose work may be taken as the next representative school which followed that of Chippendale, developing, as it were, the more useful and practical characteristics of the earlier style, and rendering it more thoroughly English in its manner as well as common sense in its forms. Sheraton, it is true, sometimes spoiled his designs by following the then fashionable love for upholstery, decking his cabinets, sofas, and tables with heavy swags of drapery festooned in gimped and fringed hangings, thought to give grace and elegance, but which really only provided receptacles for dust, and added a cumbersome frowsiness to the furniture so treated. The drawings accompanying these remarks illustrate pieces in which such trimmings were not used, excepting in the upper part of the "cylinder desk bookcase," where the curved lines of the little hangings certainly give a finished effect to the square, rigid lines of the cabinet, and being within the glass are not open to the above objections. Sheraton speaks of Chippendale's designs as already "Wholly antiquated and cast aside, though possessed of great merit according to the times in which they were executed." Of Ince's and of Maybew's designs similar remarks are made:


SKETCHES FROM THE FURNITURE EXHIBITION AT THE AGRICULTURAL HALL, ISLINGTON.
"TAMBOUR" FRONT WRITING TABLE.
CORNER CHAIR IN OAK
SIDEBOARD IN MAHOGANY, (INLAID) WITH BRASS RAIL AND HANDLES.
QUAINT ARM CHAIRS.
EXAMPLES OF ENGLISH FURNITURE SHOWN BY MESSRS JENKS & WOOD, HOLBORN VIADUCT.

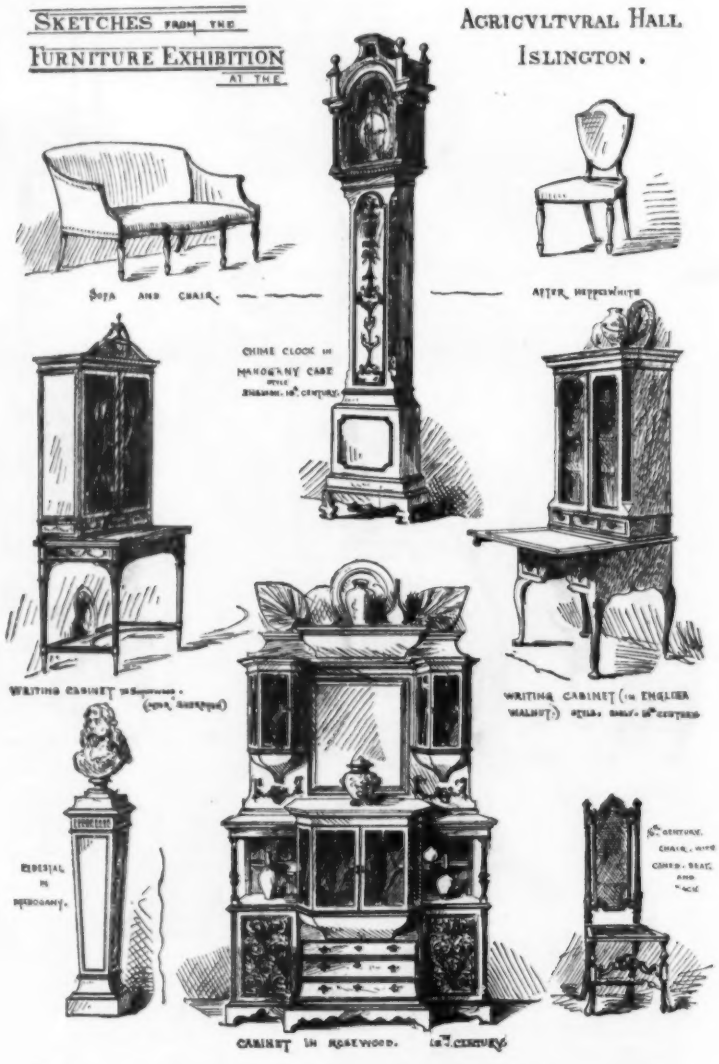

SKETCHES FROM THE FURNITURE EXHIBITION AT THE AGRICULTURAL HALL ISLINGTON.
SOFA AND CHAIR.
CHIME CLOCK IN MAHOGANY CASE
AFTER HEPPELWHITE
WRITING CABINET (IN ENGLISH WALNUT)
CABINET IN ROSEWOOD.
EXAMPLES OF ENGLISH FURNITURE SHOWN BY MESSRS JENKS & WOOD, HOLBORN VIADUCT.

table has a deep shaped frame with kneehole in center, and is supported by quaintly shaped cabriole legs. The characteristic brass handles to the drawers enhance the effect. The rosewood cabinet is in the Georgian manner, having on either side above small cabinets for the display of china, and in the center a beveled mirror surmounted by shaped bracket. The lower part is raised in the center, forming projecting cabinet, inclosed with latticed doors and bracketed down upon the lower part above three drawers. The wings have open shelves above, supported by columns, with cupboard below, the doors of which have richly carved panels. The metal work is tastefully wrought and finished a dull silver color. The mahogany pedestal is of Adams type, and the very quaint hall chair with carved back and seat is an exact reproduction of a fine old example executed in oak. The "tambour" front writing table is of dark mahogany, with brass handles to the drawers. The corner chair is of oak, from a good old model, and has the seat thinly stuffed and covered in cloth of a soft green, finished with nails. It forms a most comfortable seat. The mahogany chair with shaped seat, although taken from an English model, is decidedly French in character, and is carved with pearl beading round the frame. It is finished in brown morocco, with good effect. The sideboard with brass rail is a pretty example of Sheraton; the form is graceful, the wood very rich in color, and the original brass lion handles are suitable and good. The heart-shaped chair and that in Chippendale's broad manner are both reproductions, and are interesting examples; they are covered in the green serge cloth, finished with brass nails. Of the three quaint armchairs, that in eighteenth century French character, and the little bonheur de jour, with its figure painted panels and drapery swags, which figures from our sketch book to-day, is a typical example.

Messrs. William A. & S. Smee are large exhibitors, and their exhibits are characterized by a freshness and thoroughness which at once commend the work to those who desire furniture for everyday, practical wants, and at the same time of a tasteful appearance. Two pieces are from a bedroom suite, and the third from a dining room set of furniture. The chair is well made in fumigated oak, and has sealing wax red leather for the seat and arms. The proportions are well adapted for comfort, and without any effort after antiquarian effect, the design well becomes its intentions. The many purposes available in the walnut and rosewood toilet table can at once be seen by a reference to the sketch, and the corner wash stand, with its marble lined sides and table top, needs no recommendation for its useful adaptability.

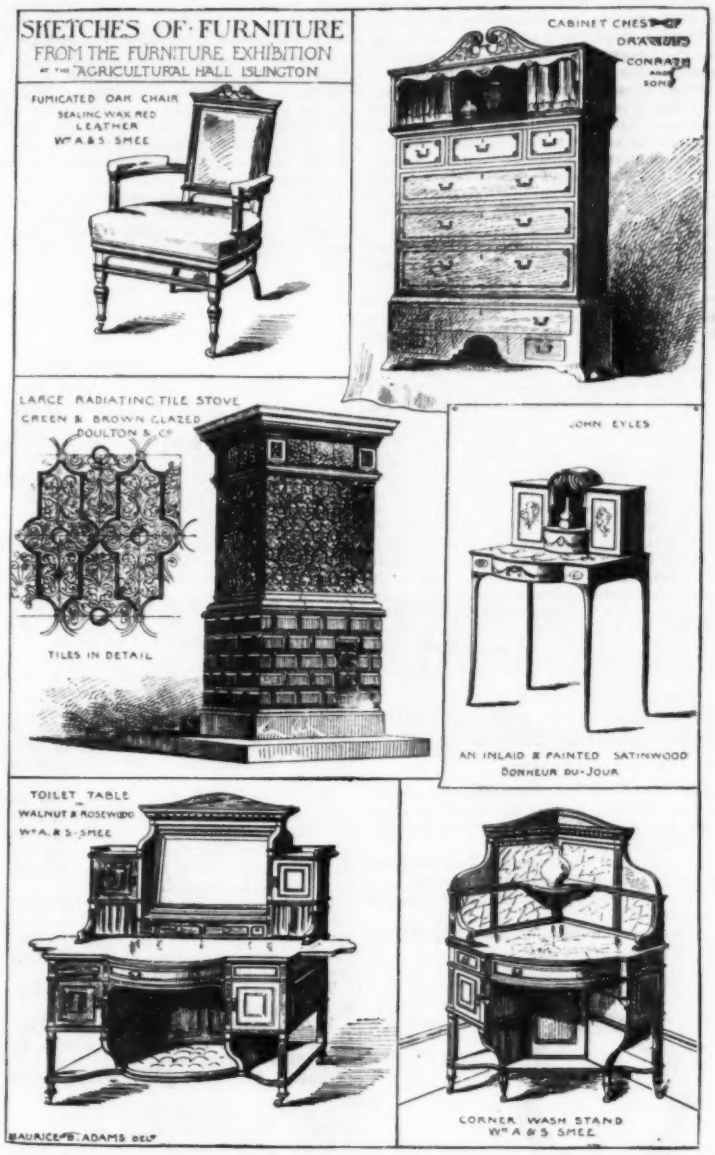
The large radiating stove, shown by Messrs. Doulton & Co., is perhaps their most satisfactory exhibit. In design, it suggests the type of terra cotta stove met with in Holland, often very richly ornamented with elaborate decorations, and always presenting a wide heating surface. The freedom of outline of the old specimens alluded to is sometimes too fanciful for domestic comfort, and the smoke arrangements generally are exceedingly primitive.

Messrs. Doulton's stove is open to neither of these objections, and the glazed majolica effect of the raised diaper green and red brown tiles is very good, while the surmounting cornice is in character, and so is the rusticated work below, the latter making a good base of rigid pattern. An open grate occurs on the other side, but our sketch gives the more satisfactory view.—*Building News.*

"The designs are of the same cast, and therefore have suffered the same fate." In justice to Sheraton's good taste, however, he further remarks in another place that Chippendale's work was "real original as well as extensive and masterly in its designs." Sheraton's contemporary, Heppelwhite, gains no such graceful acknowledgments from his hands, venturing upon invidious comparisons "with the newest taste," and leaving on record his private opinion that Heppelwhite's "designs have caught the decline," while with prophetic warmth he adds, "and in a little while they will suddenly die of the disorder." The sadness of such a prospect, even for the work of one who at times no doubt had figured as a competitor, seems to have led Sheraton to indulge in more calm and serious reflections. This predicted oblivion of his friend's work "serves to convince us of that fate," he remarks, "which all work of the same kind will ever be subject to. Yet it must be owned that things of this sort have their usefulness for a time; and when, through change of fashion, they become obsolete, they serve to show the taste of former times."

Sheraton, no doubt, was a thoroughly practical man, and a hard, earnest worker. By trade he was a cabinetmaker, and having premises in Hart Street, Grosvenor Square, enjoyed considerable patronage from the upper classes during the last twenty years of the past century, when his work was most fashionable. Personally, he does not seem to have esteemed mere fashion very highly, though ever ready to make her serve his more worthy aims. Speaking on this subject, he sums up his dissertation thus: "With respect to changes of fashions, he who is properly acquainted with lines, well versed in perspective, and sufficiently practiced

in ornamental drawing will, from a few hints, be able at any time to turn his hand to any fashion." Generally, of course, this is true enough, always provided that the style chosen be not irredeemably bad, and no doubt inherent skill masters difficulties otherwise insurmountable; but it is quite possible that skill may fail and taste degenerate, as Sheraton's work itself in his decline will show, when, like Chippendale, he sought effect in extravagances and novelties in too exuberant a fancy.



That Sheraton enjoyed a considerable opinion of himself and of his works is evident from his writings, and the following note, dated 1791, and written as descriptive of the emblematical frontispiece to his "Drawing-book," may be quoted as an instance: "To show in as pleasing a way as I could the stability of this performance and the subject of the book in general, I have, by a figure on the right hand, represented Geometry standing on a rock, with a scroll of diagrams in his hand, conversing with Perspective, the next figure to him, who is attentive to the principles of Geometry as the ground of his art, which art is represented by the frame on which he rests his hand. On the left, seated near the window, is an artist busy in designing, at whose right hand is the Genius of Drawing, presenting the artist with various patterns. The back figure is Architecture, measuring the shaft of a Tuscan column, and on the background is the Temple of Fame, to which the knowledge of these arts directly leads." He then adds this foot-note: "Time alters fashions, and frequently obliterates the works of art and ingenuity; but that which is founded upon geometry and real science will remain unalterable." And so with these high aims in view, the author commenced his labors, prefacing the development of original design by an honest study of the Five Orders "proportioned in aliquot parts," and of geometrical problems and figures.

His designs, besides illustrating admirable taste, are many of them extremely clever and ingenious for their mechanical contrivances, while, for excellence of finish and exactness of fit, it would be difficult to surpass them. The cylinder desk bookcase, illustrated to-day from his details, is an example in point. It is made of satinwood, crossbanded, and polished or varnished as it was then called. The green silk fluting to the bookcase doors is behind the glass, with the drapery swags put on at the top before the flutings were fixed. The crossbars of the doors center in a diamond ornament, which is carved and gilt, and the open verge to the top is in brass. The detail of its working parts is rather intricate, as will be seen by the section which we give, but in reality, as those who are fortunate enough to possess any perfect specimens of Sheraton's furniture will well know, the whole contrivance works with the greatest ease. I is the trammel of iron ¼ in. thick by 1¼ in. broad, to which the slider is communicated with the cylinder, so that when the former comes forward, the latter rises and discovers the nest of drawers and letter pigeon-holes, shown by our sketch of the design. When the slider or desk is pushed home, flush with the face of the front, the cylinder is brought down to it at the same time. The detail diagram over the scale shows how the lock of the long drawer under the slider secures both the drawer itself and the slider simultaneously. D is the long drawer front under the slider, S, and P is the partition between them. C is the spring-bolt let into the partition. When the drawer-lock bolt is out, as it rises it drives the spring-bolt, C, into the slider, and when the drawer is unlocked, then C falls down into its place in the partition, and the slider can be pulled out. The action of the slider is indicated in the general section by the dotted lines. U, for instance, gives its vertical position when the slider is half out, and when it is pushed home the slider is at I G. The upper slit of the trammel works on a pivot-pin, which is fixed firmly by means of the center plate, having four screw-holes. The triangular dotted lines at R *r* show thin pieces of wood screwed on to the end, to which is fixed the small nest of drawers, forming a space in the clear for the trammel to work in; and F is a ⅜ piece crossbanded and veneered, and cut behind for the same purpose, hiding the trammel and keeping the slider in its place.

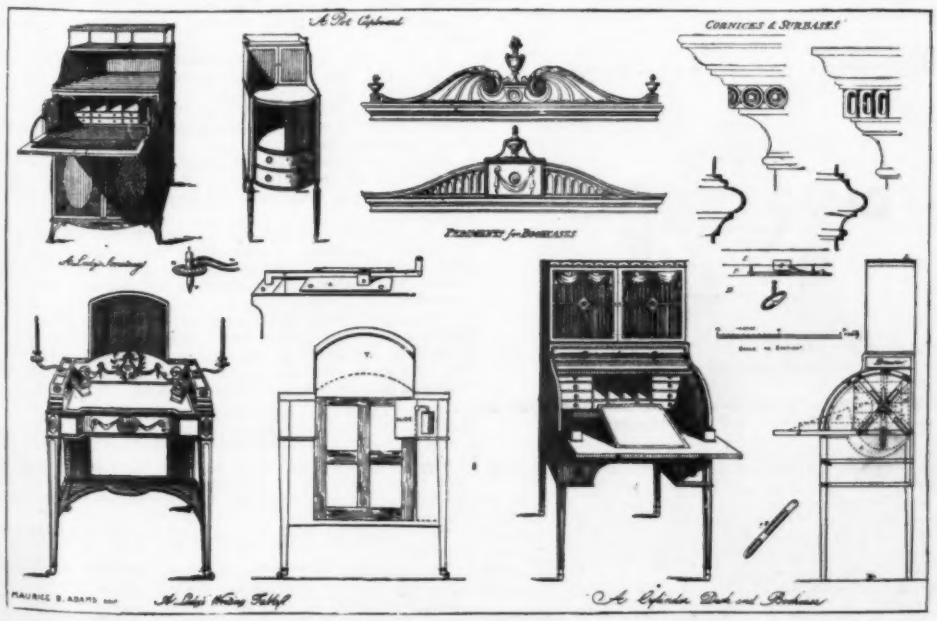
Figs. 1, 2, 3, 4 show the small drawers. The upper part of the piece containing the cylinder is made separate from the lower half containing the two heights of drawers below the slider. A is intended to illustrate how the rail of the lower framing is cut out to make room for the trammel. There is a sham drawer front in the usual way, which fastens down the slider and goes in with it like the ink and pen drawers on either side of the rack desk in center. These drawers help to steady the action of the slider, and are rather unusual features. The lady's writing table, of which we reproduce the perspective elevation and sectional diagram, is another good specimen of Sheraton's ingenuity, and certainly the design is a very admirable one. The convenience of this table is that a lady when writing at it may both receive the benefit of the fire, and at the same time have her face screened from its scorching heat. This is effected by means of a balance-hung screen, T, sliding up and down in the thickness of a boxing at the back of the table, and a small slide incloses the weights and renders them of easy access.

The small patera in the center of the back, between the inlaid ornamental swags, communicates with a spring of a similar kind to those to the drawers, and this spring keeps down the screen when the weights are up. By touching the patera the screen is relieved and rises, a start from the bottom being secured by two small springs fixed on the lower rail of the framing in which the screen works. The side boxes or hinged drawers are for ink and pens. These both fly out by force of a common spring when the knob on which the candle bracket is fixed is pressed. Fig. A is the spring plate, which is let in under the candle branch; C is a lever which is pressed to B, the end of the drawers, by a spring rising from D; N is the rim of the candle bracket, and *e* is the knob just mentioned, which is capable of being pressed down; therefore, if P be screwed into E, at end of lever, C, by pressing *e*, C rises and relieves B, which at once starts out by a common spring fixed on the inside of the boxes in the usual way. There is a drawer under the desk top extending the whole width between the legs. The table is made of satinwood and crossbanded. The desk is covered with green leather. The table is about 3 feet in total height, and about 2 feet 6 inches high by 20 inches deep.

Among our other illustrations is a piece of useful furniture known as a "pot cupboard," and thus described by Sheraton:

"These are used in genteel bedrooms, and are sometimes finished in satinwood, and in a style a little elevated above their use."

This example has a tambour door, while the two drawers below are useful additions, and so is the little cabinet medicine cupboard over the table top, with small folding doors. The legs are turned and stand firm on all fours without casters. The lady's secretary is for a private chamber, and has endless "nicknackery putaways," with a bonnet cupboard below. The piece is made in black rosewood, crossbanded with tulipwood and enriched with brass mouldings. The upper shelf is in marble, supported by brass columns and a brass ornamental verge enrichment round the edge. The two pediments are thoroughly characteristic of Sheraton's style, and the cornices and surbases give some details enlarged. The upper pediment is made in three thicknesses, having the middle piece with the grain running up and down. The foliage ornaments are cut out along with the astragal and planted on, and the whole pediment fixes with tenons into the cornice, from which it is readily removed by this means. The second pediment is very flatly treated, and the tablet part is crossbanded, with a japanned drapery swag and patera in the center.—*Building News.*



FURNITURE EXHIBITION, LONDON—SHERATON FURNITURE.

PROJECTING LANTERNS.

By C. H. STOWELL.

A GOOD deal has been said of late about projecting lanterns, and some new styles have been brought forward for public favor. One inventor has a lantern that "will actually show the circulation of the blood in the frog on a disk four feet in diameter." So much has been said that no apology is necessary if I describe my own lantern and what it will do.

After experimenting for over two years, I purchased a Marcy's lime light sciopticon about five years ago. One of Zentmayer's microscopic attachments was ordered at the same time. Two cylinders, filled with oxygen and hydrogen, respectively, were purchased from New York. For objectives I have used those from my microscope with success, although the field is flatter and lighter if objectives be used that were made especially for this work. Zentmayer makes good lenses of this kind; so do Bausch and Lomb. A one and one-half inch of Zentmayer's and a three-fourths of Bausch and Lomb make a good outfit. To work nicely the gases should be under heavy pressure. When the pres-

sure in the cylinders is down to 60 or 70 pounds, I do not have such good results. In that condition they are generally sent to Detroit—only 40 miles distant—and filled to 200 pounds pressure.

With this simple outfit I illustrate my lectures on Histology. A transverse section of the spinal cord of a pig can be enlarged to ten feet in diameter on the screen. To show the nerve-cells a power of 500 diameters is easily obtained. The cells will show so clearly that their poles can be counted and their nuclei clearly discerned. Sections of injected kidney, liver, intestine, etc., show very clearly and beautifully as well. Sections of cancer will show the stroma and cells. Pneumonia lung will show air cells six inches in diameter more or less filled with the exudate.

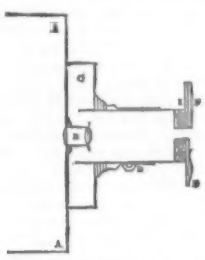
One of Dr. A. Y. Moore's double stained blood slides will show the individual corpuscles and their nuclei at a distance of 20 feet from the screen very clearly. This is true with a disk six feet in diameter. The striæ and sarcolemma of muscle can be exhibited also. The circulation of the blood is simply no trick at all. I have exhibited this, using the tongue of the frog, on a disk 12 feet in diameter.

By a simple device opaque specimens are thrown upon the screen. In this way a frog is pithed, the thoracic walls removed, and the heart beating *in situ* exhibited. The heart will appear about a foot in length and will powerfully contract, stimulated by the heat of the light. The heart may be removed from the body, pinned to a card, and this thrown on the screen, still there is vigorous motion.

Again the heart may be halved and quartered, yet still the pieces will be seen to contract. No complex or wonderful apparatus required. Two hundred dollars and a little patience and ingenuity will go farther than some fifteen hundred dollar outfits.—*The Microscope.*

PHOTOMICROGRAPHY WITHOUT A MICROSCOPE OR MICROSCOPIC OBJECTIVE.

WE took a small Ross "postage stamp lens" we possess, and fitted it on to the front of a copying camera capable of extending to twenty-eight or thirty inches. This lens we may, in passing, explain is nothing more or less than a portrait combination in miniature. It is something under three-quarters of an inch in diameter, and about one and three-quarters of an inch equivalent focus. To use it for our present purpose we, of course, required something to support the object to be photographed, at the same time permitting its being adjusted in any position, and also capable of being used as a rough means of focusing or regulating the size of the image; in fact, to take the place of the stage of a microscope had one been employed. This is how it was accomplished. On the front of the camera we fitted a shallow box after the manner of an "elongating cone," and on this was screwed the mount of a quarter-plate portrait combination from which the glasses had been removed. In the place occupied by the front lens was fitted a plug of wood, on which was glued a flat piece of mahogany three inches by four, and a quarter of an inch or so thick. A hole, an inch in diameter, was then made with a center bit through the two pieces of wood corresponding with the axis of the small lens. A couple of flat brass springs screwed on to the mahogany served to hold the microscopic slide in position. This completed the arrangement. By this simple contrivance, which any one can make for himself, we had the rack and pinion of the portrait lens to focus with, which gave us a range of about one and a quarter inches—quite sufficient for all purposes with the lens we were using. The annexed diagram, showing the arrangement in section, will make it better understood.



A A, camera front. B, miniature lens. C, elongating front. D, quarter-plate lens mount. E, stage. F F, springs to hold the object slide in position.

The light was condensed upon the object by an ordinary bull's eye condenser, the source being a single wick paraffine lamp. It may here be explained that in all cases where a photographic lens is employed, unless it be symmetrical in its construction, the posterior glass should be arranged next the object to be photographed. The class of objects we experimented with were familiar ones, such as the sting of a wasp, the tongue and the eye of a fly, tongue of drone fly, etc., and we found the definition given by this lens was as fine and crisp as anything that could be desired—quite equal in the center to that given by a very good inch objective in our possession, while at the margin of the image it was far more perfect. This was scarcely to be wondered at when we consider that it was longer in focus, and that a photographic lens is corrected to give an image on a flat surface, and not on another lens. With regard to the size of the image obtained, we may as well mention here that with the camera we employed, when fully extended, the tongue of the blow-fly measured about two inches and a quarter to two and a half inches—a very suitable size for the magic lantern.

We next proceeded to test some other lenses for the purpose, having modified our fittings to suit them. One of a pair of single lenses of French make three and a quarter inches focus, which, when employed as a wide angle landscape lens for stereoscopic pictures gave capital definition, was next tried; but it proved useless for our present purpose, as it would not produce a crisp and well defined image, although stopped down equal to *f*. 45. At this we were somewhat disappointed, considering the exceedingly sharp pictures we had taken with it.

The next lens we experimented with was a small portrait combination, about three and a quarter inches equivalent focus, and an inch in diameter—a "locket lens" of French manufacture. This, when stopped down to half an inch, gave very fair definition indeed; but by no means so crisp as that by the Ross lens with its full aperture.

We next took a double combination stereoscopic lens of English manufacture, of large aperture and about four and a quarter inches equivalent focus, such as are made for "instantaneous" work. This gave admirable definition on all portions of the image; but, owing to its length of focus, it was not suitable for such small objects as we had tested the other lenses upon, as the image was too diminutive unless the camera be inconveniently long. But for objects of larger size, however, it answered perfectly.

We had now exhausted our stock of short focus lenses, but there is one other we should have liked to have tried for the benefit of our readers if we had had one, namely, the smallest size "portable symmetrical," which is about three inches equivalent focus; as we know these lenses are capable of yielding exceedingly fine definition, they would doubtless be found very suitable for photomicrography.

In our experiments we employed a camera, as in this instance it was more convenient to do so; but it is manifest that by fitting the apparatus shown in the diagram inside a box, as in Mr. White's arrangement, it may be dispensed with—indeed, in actual practice, we ourselves never use one. Although, as our experiments prove, many photographic lenses of short focus may with advantage be employed for the delineation of microscopic objects, it must not be taken for granted that all can simply because they are of short focus; for it is clear that, unless they are capable of yielding the very finest possible definition, they are worthless for the purpose.

The lenses of our best English opticians, as a rule, fulfill this condition; hence they can generally be relied upon. The so-called "gem lenses" would be very suitable indeed, so far as focal length is concerned, although we have not tried them for the purpose; we imagine, however, from the price at which they are sold, they cannot be very perfectly corrected instruments.

It must not be assumed that photographic lenses can ever be made to take the place of object glasses of high powers for the delineation of very minute objects, as their defining power will not be sufficient; and, even if it were, the distance at which the prepared plate must be from the object would be so great as to render it impracticable. But, for the more popular familiar objects, such as *acari*, parasites, tissues, etc., or for such objects as low powers of an inch or lower, they, if good, will answer quite well, and possess some advantages over the microscopic objective. They have no chemical focus, which most object glasses of low power have. They can easily be stopped down, so as to obtain depth of definition when the object is not a flat one, as in the case of photographing some of the larger objects. Indeed, for practical purposes a well corrected photographic lens of short focus will be found more convenient to use, and will often give a better result photographically than many microscopic objectives of low power.—*British Journal of Photography.*

A LABORATORY FILTER PRESS FOR RETAINING THE MOST FINELY DIVIDED PRECIPITATES.

By JERVIS EYRE FOAKES.

IT may be of some interest to those acquainted with the various apparatus for filtering, to learn the result of some experiments performed by a filter press, constructed on what appears to be an entirely new principle.

With it several substances, whose nature has rendered them scarcely possible to filter by the ordinary process, have with the greatest ease been seperated from the liquids in which they were suspended.

The apparatus consists of a solid flat glass ring (Fig. 1)

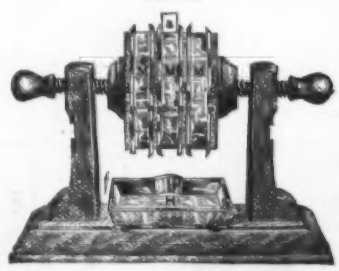
FIG. 1.

a, inlet. B, hole for the escape of air whilst the press is filling.

5 inches in its internal and 6 inches in its external diameter; thus leaving a surface or band of ½ inch on each side, which is ground perfectly even, and parallel to the opposite side. The breadth of the ring is generally about 1 inch, but may be less, when the liquid contains little solid matter, and where the formation of a solid cake is not so much the object as quick filtration.

A diaphragm of plate glass 6 inches in diameter, whose surface is covered by a filter paper, or fine linen cloth, projecting about ½ inch beyond the whole circumference, is placed on each side of the ring, the flat band of the ring pressing the paper or linen against the diaphragm.

FIG. 2.



M M, glass rings. *d d*, diaphragms. *a*, inlet for liquid to be filtered. P P, filter-papers.

The ring and diaphragms are then screwed tightly together in a wooden or iron stand by means of two screws having a flat disk of wood at their end. A series of rings with their corresponding diaphragms (Fig. 2) may be used instead of one; but in this case it is necessary that three or four holes be made through each diaphragm and its covering, to allow the liquid to pass into the adjacent ring, each hole being opposite to the one in the next diaphragm.

A tube is attached to the knob (*a*, Fig. 2) to admit the liquid to the interior of the rings, which is supplied continuously while the press is working by a pipe leading from a sufficient height to produce the necessary pressure, the amount of this pressure varying with the elasticity and fluid state of the substance to be dealt with.

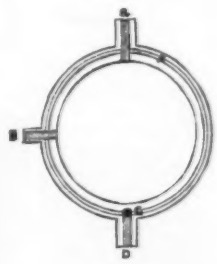
Directly pressure is applied filtration commences, all the insoluble matter being left in the hollow of the ring, or rings, while the soluble contained in the filtrate passes laterally, or radially, outward along the faces of the diaphragms, to the circumference, and finally escapes, running down the outside of the press into a vessel (H, Fig. 2) placed beneath to receive it.

The flow from the press depends on the number of rings, their diameter, the kind of covering placed on the diaphragm, the pressure at which the liquid is supplied, and the nature of the substance under treatment.

Filtration is produced not only along the flat band of the ring, as might be imagined, but is evenly distributed over the surface of the filtering material; for, upon examination of the paper or cloth after the press has been working for a short time, it will be noticed that there is a deposit of equal thickness over the whole surface of that part of the covering which is exposed to the liquid inside the press.

Where it is of importance that the liquid should not be exposed to the action of the air during filtration, a groove (F, Fig. 3), ¼ inch in depth, is made in the flat band, and a hole (G, Fig. 3) is drilled through the rings, diaphragms,

FIG. 3.



and the material with which they may be covered, connecting all the grooves in the series with a single outlet (D, Fig. 3) at the bottom of the press.

For general use, where presses of large diameter are required, the ring is dispensed with, and its place is supplied by a buffing, or band of cotton, sewed round the edges of the diaphragms; the whole surface, including the buffing, being covered by the linen cloth. In cases of this kind the diaphragms are made of metal, or whatever material is best suited for contact with the body to be filtered.

Where large quantities of a fluid have to be passed through the press at high pressure, it is preferable to employ the direct action of steam rather than that of a force pump; for ordinary purposes a pressure from 10 lb. to 60 lb. to the square inch is sufficient, but this may if necessary be increased to as much as 120 lb.

It is believed that this press has not till lately been applied to laboratory work, and it appears probable that by some slight alterations with regard to size and shape, it may become a great assistance in the collecting and washing of precipitates in quantitative analysis.

This press has been patented, and is known commercially as Bowing's filter press.

With a small laboratory press, the following results were obtained in the laboratory of King's College. The ordinary filter papers were used, and in none of the experiments had the liquid to be passed through more than once.

1. *Barium Sulphate*—precipitated from a cold neutral solution; filtered to a clear liquid.
2. *Precipitated Sulphur* (without boiling); filtered to a transparent liquid.
3. *Sulphide of Nickel*, prepared by precipitating nickel sulphide with excess of ammonium sulphide, producing a muddy brown liquid, which passes through an ordinary filter; filtered to a clear yellow.
4. *Guaiacum Resin*—dissolved in alcohol, and a few drops added to a large proportion of water, yielding a milk-white solution; also filtered to a clear liquid.
5. *Faraday's Gold*—preparing by dissolving 1 grain of gold in *aqua regia*, evaporating to dryness, and adding a quart of water to the chloride obtained. On adding phosphorus dissolved in ether, and gently heating, or leaving the solution to stand for several hours, a deep color is imparted to it. This color has been shown to be entirely due to the presence of finely divided gold suspended in the liquid.

If the flasks used in the preparation of this gold be carefully washed with distilled water to remove the last trace of saline matter, the liquid assumes a brilliant ruby-red color, which may be changed to a deep purple or blue by stirring with a glass rod which has been previously dipped in a solution of common salt.

Faraday, speaking of the ruby gold, says: "The state of division of the particles must be very extreme; they have not as yet been seen by any power of the microscope."

The following colored golds were filtered with the press to colorless liquids: Purple, blue, and ruby-red. A portion of the last was also passed through an ordinary filter-funnel and paper ten times with hardly any perceptible alteration.

It is a remarkable fact that even with these difficult substances, should the filter paper get torn while the press is in action, the filtering is in no way impaired unless the paper be damaged between the flat band of the ring and the diaphragm.—*Chemical News.*

ARTIFICIAL FUEL.

THE process of Mr. E. F. Loiseau for making artificial fuel from coal-dust is in successful operation in Philadelphia, where from 80 to 300 tons, according to size of the lumps, are made daily.

The process of manufacture may be briefly outlined as follows:

The coal dust is fed into hoppers, together with about eight per cent. of bituminous slack, from which it passes through a series of four cylindrical revolving drums, in which it is thoroughly dried. From these it is carried to a receptacle situated near the press. The dust, still at a temperature of about 140° F., is then thrown into the mixing

apparatus, in which it is thoroughly stirred by revolving shafts with blades, while the proper quantity of pitch and coal-tar is added from a reservoir in which it is maintained at a temperature of 180° by steam heat. The pitch is mixed with a certain quantity of coal-tar to give it the proper toughness. When thoroughly mixed with the melted pitch, the mass is plastic, and can readily be moulded into any desired shape. It is then carried to the press, where it is delivered between rolls having moulds upon their surfaces, from which the egg-shaped lumps are discharged. When discharged from the press, the lumps are quite hot, and have to be cooled by jets of water.

As thus prepared, the fuel is compact and very hard. Formerly clay was used as a cementing material, but now no incombustible or ash-producing material is required. The fuel is said to be even superior to the natural coal; and this opinion is borne out by an analysis, which gave the following results:

	Chestnut anthracite.	Loiseau fuel.
Carbon	73·40	82·01
Hydrogen	3·09	2·56
Moisture	0·44	2·41
Ash	17·95	10·47
Nitrogen and oxygen by difference	5·12	2·55
Theoretical calorific power, British thermal units	12,339·50	13,853·00
Equivalent to the evaporation, from and at 212°, of lb. water	12·76 lb.	14·33 lb.

PHOTOGRAPHIC ACTION STUDIED SPECTROSCOPICALLY.

AT a recent meeting of the Chemical Society, a lecture on this subject was delivered by Capt. W. De W. Abney. The lecturer said that he wished all chemists to become photographers, for photography occupied the border land between chemistry and physics. The days had been long past when black fingers were a necessary concomitant of photography; at the present time there was a vast number of amateur photographers, but there were but few who studied the scientific aspect of photography. By most experimenters it was looked upon as a servant to be abused rather than used, and the majority were content with working by rule of thumb. The lecturer was firmly impressed with the fact that photographic action is interatomic. He had already shown in a previous paper that throughout the absorption spectra of a series of organic compounds, the absorption due to hydrogen should be recognized. Something of the same kind seems to occur in inorganic chemistry. Probably the first photographic action with which most chemists become acquainted is the blackening of chloride of silver by light.

Now if this salt be perfectly dry and perfectly free from organic matter, etc., it will not blacken when exposed to light. Two tubes were exhibited, both of which had been exposed for some time to the action of light. In one the chloride was quite white, in the second the chloride, which was moist, had blackened. The action of developers was then discussed. A picture on iodide of silver paper, which had been previously exposed, was developed before the meeting with gallic acid and solution of silver nitrate. The action of the light is to liberate free iodine, and the developer precipitates metallic silver to form the image. The number of particles acted on by the light must be extremely small.

The image can be washed off with nitric acid, and a fresh picture taken on the same film. A second image was developed with citrate and oxalate of iron; in this case the metallic silver must have been obtained from the film itself. Some other experiments were shown proving the truth of this statement. Development is not a chemical but a physical action. It was found on photographing the solar spectrum that the amounts of energy in different parts were very varied and irregularly distributed; recourse was had to the positive pole of the electric arc light. The incandescent light had not sufficient energy, but the positive pole furnishes a spectrum which has sufficient energy, and is much more uniform than the solar spectrum.

For producing the spectrum every one would probably first choose the diffraction grating, but it was found that a perfect grating did not exist, and one grating differed so much from another, owing to minute differences in the ruling, that eventually a glass prism was adopted, as the grating could not be relied on for quantitative work. Films of chloride, bromide, and iodide of silver were successively interposed in the beam of the electric lamp, and it was shown that the chloride partially cut off the violet end of the spectrum, the iodide absorbed the whole of the violet, but the bromide cut off part of the blue, as well as the violet. An image of the spectrum was then thrown on films containing respectively silver chloride, bromide, and iodide, and the plates were developed with ferrous oxalate. It was seen that with the chloride but a small portion of the spectrum had acted on the silver salt, and that with the bromide a very much larger image was obtained.

The action of sensitizers was next considered. The part played by a sensitizer is the taking up of the chloride, bromide, or iodine set free by the action of light. To demonstrate this action an image was thrown on to a sensitive plate, and during the exposure a streak was made across the plate with a solution of sodium sulphite; on developing, a black stripe indicated the position of the sodium sulphite, this salt having rendered the silver salt in its vicinity more sensitive. A sensitizer is useless unless it be close to the salt on which it is to act; so all sensitizers are more or less hygroscopic, or they may act in solution or as vapor. Almost any organic compound acts as a sensitizer. The lecturer then gave instances of colored sensitizers, and photographs of the spectrum were taken on films colored with cyanin blue, and with eosin.

The plates were developed, and the relation between the portion of the spectrum photographed and the portion absorbed by these pigments demonstrated. Thus cyanin blue absorbs the yellow, and the photograph of the spectrum on the film colored with cyanin blue exhibits a band in the yellow where the absorption had been previously seen. It is very remarkable that one salt of silver may act as a sensitizer to another salt of silver. Thus a film containing bromioxide of silver photographs much more of the spectrum than films containing the one bromide and the other iodide. It is easy to destroy the results of photographic action. If a film during exposure be washed with any oxidizing agent, as potassium permanganate, or bichromate, dilute nitric acid, peroxide of hydrogen, etc., the image is completely effaced. Thus, if plates which are foggy from accidental exposure be dipped in dilute bichromate of potash and well washed, they are restored to their original condition.

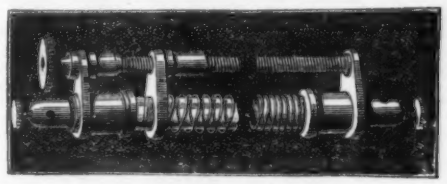
This bleaching effect was demonstrated by throwing a picture on a sensitive plate, and during exposure making a streak with bichromate solution across the plate. On developing, this streak was seen to be white. A sensitive plate after exposure to light was soaked in dilute nitric acid containing one drop of acid in 8 ounces of water and then exposed to the spectrum; the tendency of the nitric acid was to oxidize; at the violet end, where the reducing power of the light was at its maximum, this tendency was overcome, but the red end was perfectly white. A method of retaining a reversed image was demonstrated. A sheet of iodized paper was exposed to light, then immersed in potassium bromide solution; a picture was then thrown on it; on developing it was found to be reversed. An instructive experiment was also shown of an easy means of preventing the bad results of over exposure.

An extremely sensitive dry plate was soaked in sodium sulphite solution and exposed for sixty seconds to a bright spectrum. On developing, a good picture came out not in the least reversed. So a picture cannot be reversed if some substance is present in the film having a great affinity for oxygen. A beam of light was transmitted through films of the three varieties of silver bromide: the ordinary variety was orange, the film used in the gelatin dry plates a sort of French gray, the film used for photographing the ultra-red portion of the spectrum, green. In conclusion, the lecturer said he had endeavored to point out to the chemists present some of the pitfalls which beset the practice of photography.

DE COMBETTES'S RHEOSTAT.

FOR certain electric operations—in electro-metallurgic experiments, for example—it often becomes necessary to keep the current quite constant for several hours in order to make it possible to calculate, through the duration of the current's passage, the quantity of metal deposited.

Whatever be the pile employed as a source of electricity, it gradually becomes weak in consequence of the changes undergone in the composition of the liquid or liquids used in it. This weakening, then, must be compensated for by a resistance interposed in the circuit, and the amount of which



DE COMBETTES'S RHEOSTAT.

is gradually lessened. The Wheatstone rheostat answers very well for this purpose, but that is a costly apparatus which may be economically replaced by the arrangement devised by Mr. De Combettes and shown in the annexed cut.

This rheostat is formed of a German silver wire wound into the form of a spiral of an indefinite length and with a gradually increasing pitch. The process employed by Mr. De Combettes to form these spirals with graduated pitch is as simple as ingenious. The spiral is put on a tube of glass having a diameter smaller than its own, thus allowing it to flatten and elongate freely in a longitudinal direction, like a spring. One of its extremities (the one corresponding to the shorter pitch) is fixed to a brass mounting placed at the extremity of the tube, and the other is connected with a brass disk which presses against the spiral, and is capable, by the aid of screw maneuvered by a button, of moving longitudinally and tightening up the spires against each other. This movable piece establishes a communication with one terminal through the intermedium of the screw.

In the position shown in the figure, the current, in order to pass from the left to the right terminal, is obliged to pass through the entire spiral. It goes without saying that the left extremity of the screw is insulated from the piece that holds it. When the spiral is compressed by turning the screw, the spires come in contact successively in the part in which the pitch is smallest, and establish between them a direct contact that diminishes the interposed resistance until all the spires are in contact. If, at the beginning of the operation, care has been taken to have a sufficiently powerful pile by interposing a suitable resistance, we shall be sure, on maneuvering the screw, of keeping the current constant until the rheostat has reached the end of its travel. It is only necessary to watch the behavior of the current by means of a simple galvanometer, and to maneuver the rheostat, in order to keep the needle always on the same derivation.—*La Nature.*

EXHIBITION OF ACCUMULATORS IN THE HALLS OF THE SOCIETE D'ENCOURAGEMENT, PARIS.

THE accompanying engraving, which we borrow from *L'Electricité*, represents the exhibition of accumulators which recently occurred at Paris on the occasion of a seance given by the Société de Physique to delegates from the various scientific societies of that city.

The accumulators exhibited belonged to two very distinct categories. Those that are seen lying upon the table were such as were designed for lighting ordinary and palace cars on railways. In order to show how convenient this mode of producing light is there were placed alongside of each lamp the number of accumulators necessary to supply it for a length of time greater than that it takes to make the longest railway trip on a French railroad.

Although the boxes are seen to be of unequal dimensions, this is because the lamps themselves were far from having an identical power. The large boxes supplied the largest lamps. Besides, some of these boxes—those in the center of the table, for example—supplied three lamps in a cluster designed to be used as a chandelier for parlor cars. The lamps suspended from the ceiling were supplied by accumulators placed on carts in the street.

The electricity entered and made its exit through two perfectly insulated cables, not figured in the cut. These lamps were all more powerful than a single gas burner consuming 140 liters per hour. The light was so brilliant as to recall that of the day time, while of course there was an entire absence of heat from it. Had an equal number of gas burners been used, the audience would have been literally roasted.

The smallest of the boxes upon the table—the one figured in the foreground—weighed but a few kilogrammes, and would have fully sufficed to light up brilliantly the car of the most gigantic balloon.

The three female operators in the back part of the hall each ran a sewing machine, and had beneath her feet a small box containing the number of accumulators necessary to actuate the machine for seven entire days. It is useless to add that the regularity of the motion was as perfect as that of the light. One of the features that renders the accumulator of great value for domestic purposes is the instantaneousness with which it may be set in action, a simple contact, only, being necessary to cause it to give either the light or the power that may be needed.

DEVIATIONS OF THE COMPASS.

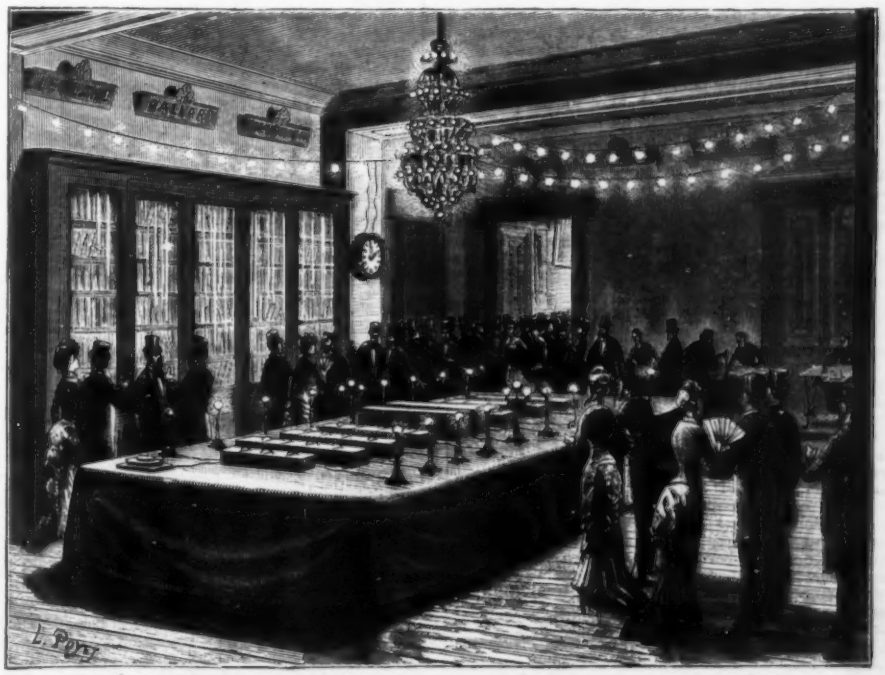
AT a recent meeting of the Royal Society, London, a paper was read "On the Changes which take Place in the Deviations of the Standard Compass in the Iron Armor-plated, Iron, and Composite-built Ships of the Royal Navy on a Considerable Change of Magnetic Latitude," by Staff-Commander E. W. Creak, R.N., of the Admiralty Compass Department.

The period comprised between the years 1855–68 was one of active research into the magnetic character of the armor-plated and other ships of the royal navy and iron ships of the mercantile navy.

Among other contributions to this subject a paper by F. J. Evans, Staff-Commander R.N., F.R.S., and Archibald Smith, F.R.S., was read before the Royal Society in March, 1865, relating to the armor-plated ships of the royal navy, and containing the first published results of the system of observation and analysis of the deviation of the compass established four years previously.

From lack of observations in widely different magnetic latitudes the authors of that paper were unable to define the proportions of the semicircular deviations arising from vertical induction in soft iron and that arising from permanent or sub-permanent magnetism in hard iron.

During the last fifteen years vessels of all classes—except turret ships—have visited places of high southern magnetic inclination or dip, and the analysis of the deviations of their standard compasses has been made, showing the constants of hard and soft iron producing semicircular deviation.



EXHIBITION OF ACCUMULATORS, PARIS.

The constants for soft iron provide a means of predicting probable changes of deviation on change of magnetic latitude for certain vessels of the following classes, and others of similar construction:

1. Iron armor-plated ships.
2. Iron cased with wood.
3. Iron troopships.
4. Iron and steel cased with wood.
5. Composite built vessels.
6. Wooden ships with iron beams and vertical bulkheads.

These vessels were all in a state of magnetic stability previous to the observations which have been discussed, and their compasses have had the semicircular deviation reduced to small values, or corrected in England by permanent bar magnets.

This correction may be considered as the introduction of a permanent magnetic force acting independently, and in opposition to the magnetic forces of the ship proceeding from hard iron.

It is now proposed to consider the effects of a change of magnetic latitude on the component parts of the deviation.

SEMICIRCULAR DEVIATION.

On semicircular deviation from fore and aft forces, time has but little effect, and the greater part of it is due to permanent magnetism in hard iron, which may be reduced to zero for all latitudes by a permanent magnet.

A second but small part of this semicircular deviation proceeds from sub-permanent magnetism in hard iron. It is subject to alterations slowly by time, from concussion, and from the ship remaining in a constant position with respect to the magnetic meridian for several days, and is more intensely affected by a combination of the two latter causes.

Deviations from sub-permanent magnetism which have temporarily altered in value as described, return slowly to their original value on removal of the inducing cause.

The principal cause of change in the semicircular deviation on change of magnetic latitude, in corrected compasses, arises from vertical induction in soft iron, which changes directly as the tangent of the dip.

In standard compasses judiciously placed with regard to surrounding iron this element of change is small and similar in value for similar classes of ships.

With very few exceptions, nearly the whole of the semicircular deviation from transverse forces is due to permanent magnetism in hard iron subject to the same laws as that proceeding from fore and aft forces.

In the exceptional cases alluded to there is a small part due to vertical induction in soft iron, changing directly as the tangent of the dip.

QUADRANTAL DEVIATION.

This deviation is caused by induction in horizontal soft iron symmetrically placed, and it does not change with a change of magnetic latitude. Time alone appears to cause a gradual change in its value during the first two or three years after the ship is launched, when it becomes nearly permanent.

The diminution of the mean directive force of the needle, which is common to all modern vessels of war, improves slowly at first by lapse of time, and assumes a permanent value.

RELATIVE PROPORTIONS OF HARD AND SOFT IRON.

It has been found that the relative proportions of the hard and soft iron affecting the standard compasses of twenty five vessels examined differ considerably, even in ships of similar construction.

This difference may be accounted for by the compasses not being placed in the same relative position in the ships, considered as magnets of various forms and containing numerous iron bodies introduced during equipment.

GENERAL CONCLUSIONS.

The following general conclusions have special reference to the standard compass positions in the six classes of vessels previously mentioned:

1. A large proportion of the semicircular deviation is due to permanent magnetism in hard iron.
2. A large proportion of the semicircular deviation may be reduced to zero, or corrected, for all magnetic latitudes, by fixing a hard steel bar magnet or magnets in the compass pillar, in opposition to, and of equal force to, the forces producing that deviation.
3. A very small proportion of the semicircular deviation is due to sub-permanent magnetism, which diminishes slowly by lapse of time.
4. The sub-permanent magnetism produces deviation in the same direction as the permanent magnetism in hard iron, except when temporarily disturbed (1) by the ship's remaining in a constant position with respect to the magnetic meridian for several days, (2) by concussion, or (3) by both combined when the disturbance is intensified.
5. To ascertain the full value of changes in the sub-permanent magnetism, observations should be taken immediately on the removal of the inducing cause.
6. In the usual place of the standard compass, the deviation caused by transient vertical induction in soft iron is small, and of the same value (nearly) for ships of similar construction.
7. The preceding conclusions point to the conditions which should govern the selection of a suitable position for the standard compass with regard to surrounding iron in the ship.

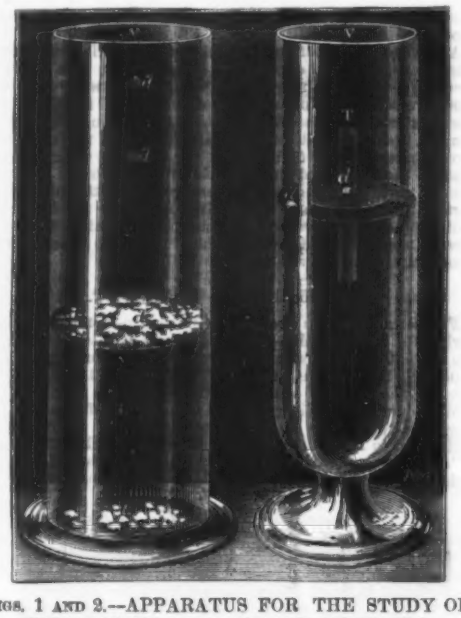
THE MOTIONS OF CAMPHOR UPON WATER AND MERCURY.

THE motions of camphor when placed in small fragments on the surface of water were observed for the first time by Romieu, who attributed them to electricity, and since that epoch (1756) the phenomenon has been the subject of labors of more or less importance. Of the latter it will suffice to recall those of Benedict Prevost, Venturi, Matteuci, Liegeois, and especially those of Dutrochet.

The illustrious author of the discovery of *endosmosis* has even drawn from his experiments with camphor conclusions having a physiological bearing, and upon which we shall have occasion to pronounce a little further along.

We shall occupy ourselves in the first place with the motions that occur in camphor when placed upon the surface of water. In order to study these properly it will only be necessary to have an ordinary table; one or two saucers; a tumbler; a cylindrical vessel or test glass, about 18 centimeters in height by 6 in diameter; a glass tube of smaller diameter and open at the extremities; a cork stopper; a water bottle (carafe) filled with pure water; a pair of pincers; a table knife; some charcoal in fine powder; one or two sheets of filtering paper; a few coins; and a pipette with a long nozzle. Provided with this apparatus, we pour into a saucer, or into the test glass, a certain quantity of water, and place on the surface of the latter a particle of camphor (*a*) of the size of a pin's head or of a millet seed (Fig. 1).

This done, we shall see the camphor begin to spin rapidly around and dart about here and there in a very capricious way. If, in order to observe these motions better, we put a small pinch of powdered charcoal in the place where they are occurring, the black powder will be seen to be suddenly repelled circularly to a certain distance from the camphor, the layers that it forms will be further divided up into smaller particles, which, after separating, will again approach each other when the camphor goes spinning about elsewhere, and so on, as long as these gyratory and side



FIGS. 1 AND 2.—APPARATUS FOR THE STUDY OF THE MOTIONS OF CAMPHOR ON WATER.

motions continue. It may happen, in fact, that these latter will cease very suddenly, especially if the saucer be touched with the fingers, or if a knife blade, a piece of money, a gold ring, a glass tube, the extremity of a hair, or the point of a needle slightly oiled be plunged into the water.

If, in performing these experiments, we employ a test glass of the dimensions that we have indicated, the camphor, after executing its gyratory motions as long as the water has not exceeded a certain level (4 or 5 centimeters, for example), will be observed to stop of itself whenever such level is raised a few centimeters through the addition of water introduced by means of the pipette, this introduction being made slowly and without shock.

In order to have the camphor resume its spontaneous motions, it will often suffice to incline the vessel, or, better

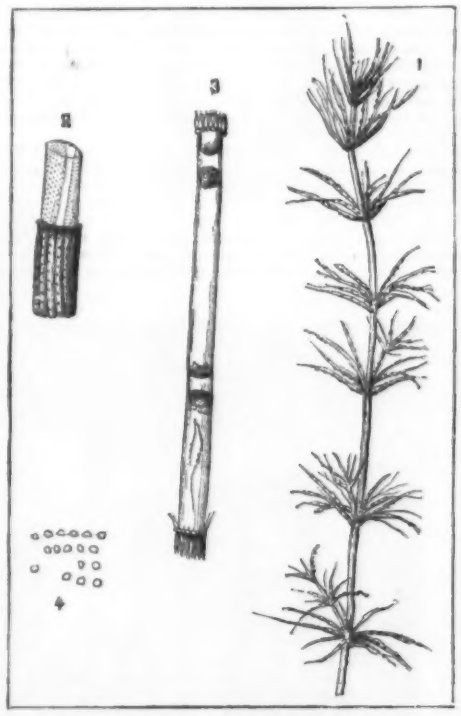


FIG. 3.—*Chara fragilis* (natural size). No. 2. Portion of an internode showing internal cylindrical cell and its tubular sheath. No. 3. Internal tube, with green matter seen by transmitted light. No. 4. Green matter or globuline, highly magnified.

still, to empty it by means of the pipette until the water has reached its former level, or a little less.

The following experiment is one of our own and possesses a certain amount of originality (Fig. 2).

Into a test glass, V, we pour a little water and place therein a clean open tube, T, which in part dips into the liquid and is held in a vertical position by means of a cork ring. Things being arranged thus, we place a small fragment of camphor (*a*) in the test glass and another one (*d*) in the tube itself. At first, a motion manifests itself in both, but, in measure as we raise the level of the liquid in the test glass, we observe the camphor therein to become slower in its motions and to soon come to a rest, while the gyration of the piece contained in the tube does not cease its rapidity. It quite often happens that the camphor in motion stops of itself in the vessel in which it is moving, and then, after a certain length of time, begins its ordinary motions again.

Mr. Dutrochet sees in this fact a *phenomenon of habit*—a phenomenon transferred by him from physiology to physics. He attributes to the water and the vessels that he uses a characteristic activity of which the camphor is the detecter. A moderate heat excites such activity, while friction arrests it by paralyzing it. The form, nature, and depth of the vessels employed, and the manner in which the water is poured into them (that is to say, with or without *collision*), has also, according to Mr. Dutrochet, a certain influence on the results obtained.

Finally, this illustrious academician believes that he can liken the *physiological* apparatus by means of which Nature causes a circulation of the liquid contained in the tubular internodes of the singular fresh-water plant called *Chara fragilis** to the physical apparatus in which the motions of the camphor occur. If such a comparison were exact, physical laws alone would suffice, then, to explain the motions of *life*.

As for the cause of the camphor's gyrations on the surface of the water, Mr. Dutrochet finds this in a new force discovered by him, which he calls *diluo-electricity*, and the existence of which was revealed to him through a study of this volatile substance.† The subject that we have just touched upon is a much more serious one, then, than it would seem to be at first sight. It touches, in fact, the highest questions of physics and biology. We shall see, in a succeeding article, how we must interpret facts of which we have more than once been the surprised and puzzled witness. We shall, for the moment, confine ourselves to saying that in experiments of the kind under consideration we should make at least ten observations if we do not wish to expose ourselves, as so often happens, to the danger of taking appearances for realities, and of drawing conclusions that are in no wise comprised in the premises. *Errare humanum est*, and no one is more convinced than myself of this sad truth.—*Prof. N. Joly, in La Nature.*

ELECTRIC FLANNEL.

WE have received from Dr. Claudet, says the editor of *La Nature*, a specimen of the new electric flannel, which, he asserts, has a very efficacious effect in rheumatism.

This flannel contains, per kilogramme, 115 grammes of the oxides of tin, copper, zinc, and iron. A series of threads of the fabric is impregnated with these metallic products, and each series is alternately separated by raw threads. The flannel thus prepared constitutes a true dry pile. M. Drincourt, professor of physics at the Lyceum of Rheims, and M. Porterin, graduate of the Polytechnic School, has each found, independently, by very positive experiments, that Dr. Claudet's flannel disengages electricity by simple contact, and, better still, in contact with the products of perspiration when the fabric is applied to the body. We have not tried the new product ourselves, but we willingly make it known as a new electric curiosity.

THE CEREBRAL ORIGIN OF DENTAL DECAY.

HARD-WORKING students force the growth of their intellectual capacity at the expense of their teeth. At all events that is the belief of Drs. Sitherwood and Hanlan, who have written on this matter in a recent number of the *Journ. de Médec. et de Chir. Prat.* It is said that the teeth undergo a rapid alteration in students who labor long, and that on the cessation of the hard work the dental disease dies away. We are quite prepared to admit that there may be some truth in these assertions. The teeth have been known to become loose and drop out apparently as a direct consequence of that protean disease, tabes dorsalis. But it is probable that even truthful Nature will be found to draw the line at the wholesale accusation of her nervous system. Why, we should have thought that the dental arches were as much without the pale of action of the much impeached mental organs as the nails and the skin. We have not heard or read whether the epithelial desquamation or the rate of growth of nails is more rapid or more perverted in beings of much cerebral action, as compared with those of their fellows who work less with their quiet brains. Explanations of this alleged fact concerning the teeth have been mentioned by a recent writer in *L'Union Médicale.* It is thought that the brain, when overworked, steals all the phosphates, and leaves none for the teeth, or else that a deterioration of the general health is brought about by the excessive study. Now, it is certainly a matter for consideration whether excessive mental work *per se* is capable of inducing serious disease. Side by side with natural mental life there probably goes on more or less unhealthy action, which bears pretty much the same relation to the former as the latter does to the friction on a steam engine. What is friction in the engine is anxiety or worry in the man. It is the friction which destroys the physical basis of the engine, and it is the anxiety that wears out the material structure of the man. So, then, all cerebral action is accompanied by the inevitable residue of anxiety or whatever else we choose to call it, but this residue may be lessened by various circumstances, and may be augmented by many conditions; and so it is that of two men of equal original health and equal original powers, but of dissimilar environment, the one succumbs because the heat of frictional anxiety has consumed him, the other lives longer because the obstacles to his vital acceptation of the first law of motion have been reduced to a minimum.—*Lancet.*

* Mr Dutrochet says: "In the suspicion that I had conceived touching the identity of these two phenomena—one of them physiological and the other physical—I compared the *physiological apparatus of Chara* to the *physical apparatus* that I used for observing the movements of camphor. This apparatus consists of: 1, a vessel; 2, an aqueous liquid; 3, of one or several particles of camphor, which move on the surface of the liquid, and which, when fixed, impart a motion thereto. The *physiological apparatus* of *Chara* consists of the same three parts: 1, of a vessel, which is the tubular internode; 2, of an aqueous liquid holding in suspension inert globules or granules; and of green globules, fixed in longitudinal and spiral series along the internal sides of the tubular vessel, and which I consider as *camphoroid bodies* having, by virtue of their electricity, the power of communicating motion to the liquid with which they are in contact."

The comparison made by Mr. Dutrochet is not correct, and, far from there being any *identity*, there is not even any *analogy* between the two apparatus and the two phenomena that he compares. The simplest observation will suffice to demonstrate this.

† According to him, *diluo-electricity*, or motive electricity resulting from a superficial or penetrating solution of camphoroid bodies placed on the surface of water, is intermediate between static and dynamic electricity, as regards the phenomena that it produces. (Cf. Mem. in *Comptes Rendus*, Jan. 4, 1841, p. 18 *et seq.*)

[Concluded from SUPPLEMENT No. 390, page 6225.]

CEREAL FOODS FROM WHAT WE EAT AND WHAT WE DRINK.

By Dr. A. T. CUZNER, Peekskill, N. Y.*

STARCH.

Starch, like sugar and fat, is a hydrocarbon represented by the formula $C_{12}H_{10}O_{10}$. It is probably the most abundant product of vegetation. It forms the great bulk of the tissues of most seeds and plants. When the pith of the sago palm is washed with water on a fine sieve, a white powder is deposited by the milky fluid that passes through. This, when collected, forced through a metal sieve to granulate it, and dried by agitation over the fire, is the sago of commerce.

When the raw potato is peeled and grated on a fine grater, and the pulp thus produced well washed with water, *potato starch* is obtained. When the roots of the Maranta crundinacea of the West Indies are grated and washed like the potato, they yield the *arrow root* of commerce. From the root of the manioc the *cassava* is produced by a similar process, and this, when dried by agitation on a hot plate, is the *tapioca* of the stores. In a solution of iodine they all become blue. Fig. 6 represents starch cells from wheat.

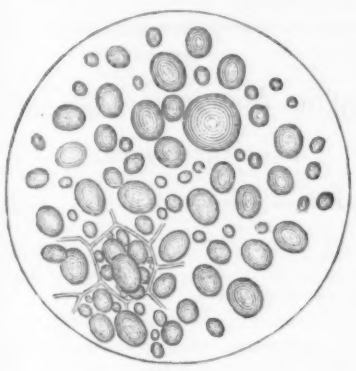


FIG. 6.

If we regard the enormous proportion in which the seeds of cereals and leguminous plants and the tuber of the potato enter into our dietary, and the immense percentage of starch in these articles, it is not exaggerating to say that fully two-thirds of the food of mankind consists of starch. Therefore its importance as an article of human food requires at our hands a more detailed consideration.

Starch, in the raw state, is to man an almost indigestible substance; but when subjected to the operation of cooking, it is readily digested. The digestion of starch in the human boby is accomplished by the saliva and pancreatic juices. These are both rich in a substance called *diastase*, and owe their power of digesting starch to it.

DIASTASE.

Starch is likewise digested in plants by the same substance (diastase). Let us examine the process somewhat.

If we take barley newly malted and crushed, pour cold water on it, and let it remain for a quarter of an hour; if the water is now poured off, filtered, evaporated to a small bulk over boiling water, and then mixed with much alcohol, a white tasteless powder falls down. This is *diastase*.

If unmalted barley be so treated, no diastase is obtained. Therefore, this substance is formed during the process of malting.

If grains of wheat (which yield no diastase before germination) be made to germinate (or sprout) and be afterward ground and treated as above, diastase will be obtained. It is therefore the *product of germination*.

If a potato be made to sprout, and the sprout cut off with a small portion of the surrounding potato, and if we cut off the upper half and examine it as described above, we find *no diastase*. If we examine the mass of the potato from which the sprout was taken or detached, we find *no diastase*. But if we examine the lower half of the sprout with the small portion of potato attached, *we find diastase*. This substance is formed at the base of the germ during germination; but it is not found after the first true leaves of the plant are fully formed and expanded. What is the nature of the temporary function performed by diastase in the plant?

DEXTRINE.

If a certain portion of diastase be added to wheat, potato, or other starch in water, and be kept at a temperature between 120° and 140° Fahr., the starch will gradually dissolve and form a colorless transparent solution.

When this solution is carefully evaporated, a yellowish white powder is obtained, perfectly soluble in water, to which the name of *dextrine* is given.

Dextrine is merely starch changed or transformed in such a way as to become soluble in cold water.

This change is similar to that which it undergoes by simply boiling in water.

GRAPE SUGAR.

But if the digestion be continued after the starch is dissolved, the solution will gradually acquire a sweet taste, and if it be now evaporated, it will yield, instead of *dextrine*, a mixture of gum and grape sugar. If the digestion be still further prolonged, the whole of the starch will be converted into *grape sugar*.

One part of diastase will convert into sugar 2,000 parts of starch.

FUNCTION OF DIASTASE.

We see by this, that one of the functions of diastase is to render soluble the starch, and so enable it to circulate in the sap of the plant. That it is the only one we have no reason to believe. In the human system the action of diastase is not limited to rendering starch soluble. In fact, it rarely has opportunity of so changing starch, for by the preparation food undergoes in cooking, starch is hydrated and rendered soluble in cold water. The function, therefore, of the diastase in the saliva and pancreatic juice is to change the hydrated starch into sugar.

Diastase does not exist in the saliva and pancreatic juice of young, suckling animals, except in minute proportion. In the human infant, diastase does not appear to exist in sufficient abundance to digest starchy matters, until about the seventh month. Therefore, foods containing starch largely are unfit to administer to young infants.

From the above examination of wheat we find that it contains all the proximate principles that enter into the composition of the human body. This being the case, it follows that if we can retain, in the food manufactured from it, these principles in the same proportion (or nearly so) as exist in the grain, we shall have a perfect food, adapted to all the wants of the human system. Does the ordinary flour of commerce and the bread made from it contain them in the proper proportion? I answer, no!

WHITE FLOUR.

Fashion has decreed that flour shall be *white*. White flour means little gluten, and, as a consequence, loss of phosphates. By careful analysis of the husk or bran of wheat, we find it to be about 5 per cent. of the weight of the whole grain. Now, as it takes about 270 pounds of wheat to make a barrel of flour by the ordinary milling process, we have (or should have) a loss of but 13½ pounds; whereas, the actual loss amounts to between 50 and 60 pounds. Of what does this loss consist—what element of the grain is thus needlessly wasted? *It is the gluten.*

We have seen in our examination of a grain of wheat, that the principal mass of gluten lies between the bran and the starchy mass.

PROCESS OF MILLING.

When the grain is crushed between the mill stones, the layer of gluten sacs breaks up into fine scales which adhere firmly to the bran, but readily detach themselves from the crumbling starch. Part of these scales, by the continuous attrition of the burr, are torn from the bran and enter the bolting cloth, which from their irregular shape they pass through with difficulty, and much more slowly than the round granules of starch. But the larger proportion adhere to the bran and with it are separated from the flour.

DARK FLOUR.

I must caution the reader in this place not to understand us as teaching that because a flour is dark in color it must necessarily be good, and rich in gluten. Flour may be dark in color from various causes other than the gluten it contains. First, the wheat used may be a dark and impure variety. Second, shriveled or blasted grains, together with foreign seeds, may be ground up with good wheat, and so discolor the flour. Third, a large portion of bran may be ground and mixed with the flour, and discolor it. Therefore, while a dark flour *may not necessarily be a good flour*, we cannot have a *very white flour* containing *much gluten;* for it is the starch that constitutes its whiteness, while gluten gives its color. But it will be asked by the reader, If the above statements are correct, how is the average reader to tell the difference between two or more flours, their color being dark, as to whether they are rich in gluten and devoid of the outer bran coats or foreign coloring materials? I answer, it cannot be done without the aids of chemistry and the microscope.

BEST FLOUR.

I have been asked by quite a number of persons, "Is not the New Process Flour a *perfect flour?*" to which I have been compelled to answer, *No!* Now, while the Minnesota New Process Flour, *as a white flour*, is far superior to the average white flour of commerce, yet it is sadly lacking in the proper proportion of gluten. There are, however, several flours that can be obtained in the market that come near to what a perfect flour should be. Among these, the Franklin Mills Flour of the Entire Wheat, Lockport, N. Y., T. R. Beardsley, Mill Agent, 77 Warren Street, N. Y., stands pre-eminent. The following report of the Connecticut Agricultural Experiment Station, under the direction of Prof. S. W. Johnson, of Yale College, shows the difference between the New Process Flour and that of the Franklin Mills Entire Wheat as to the amount of gluten they each contain, and is decidedly in favor of the latter.

CHEMICAL ANALYSIS OF WHEAT FLOUR BY PROF. S. W. JOHNSON.

Minnesota New Process.		"Water Free," Franklin Mills Entire Wheat.	
Starch, sugar, etc.	83·86	Starch, sugar, etc.	78·46
Albuminoids	14·12	Albuminoids	16·20
Crude fiber	0·08	Crude fiber	1·39
Fat	1·37	Fat	2·30
Ash	0·57	Ash	1·65

The process adopted by the Franklin Mills is essentially as follows:

By improved machinery they remove from the grains of wheat the three outer bran coats and reduce the remainder to a fine flour. In this process they use no mill stones, therefore the flour is not heated during the process of manufacture. From the above analysis we find that the Franklin Mills Entire Wheat Flour, Lockport, N. Y., contains about 15 per cent. more gluten than the New Process Flour.

There is another flour (or rather meal, for it is not ground fine enough to constitute a flour) sold in the market that meets all the requirements of a perfect food. I allude to Mead's hulled wheat flour, manufactured by A. F. Mead, 10 Leonard Street, New York.

This meal is manufactured from a soft wheat after it has been perfectly hulled.

It is not bolted, therefore, all the constituents of the wheat are retained, excepting the three outer coats.

This meal shows well under the microscope.

The Arlington wheat is a pure Grahan flour; it is rich in gluten, but contains the outer bran coats, and is, therefore, somewhat objectionable.

Having examined the structure, proximate principles, and the properties of a grain of wheat, let us now consider how this grain can be made available, in a most palatable form, for man's use as a food. In other words, let us consider the process of bread making.

BREAD MAKING.

There are two kinds of bread manufactured; the one is made with yeast, ferment or leaven, and is hence called leavened; the other is prepared without leaven, and is called unleavened bread.

The object of both processes is to render the dough, both before and during baking, light and porous. Now, in order that a porous structure in the dough may be obtained, it is necessary, first, that the flour should have a constituent which, when moistened with water at common temperature, shall possess two of the properties of India-rubber, tenacity and elasticity; and that these properties shall, in a great degree, be lost on subjecting the moistened flour or kneaded dough to a certain elevated temperature. Second, that an *agent* be added that is capable, by the influence it exerts on the constituents of the flour, to cause them to take on such an action as shall result in the evolution of gas; this gas being generated in every part of the dough, in its efforts to escape distends it, and every part becomes cellular in structure. This structure is rendered permanent by the application of heat in baking. This agent is yeast.

YEAST.

The way yeast operates in the fermentation of flour is as follows:

When yeast is added to any substance containing sugar, it induces certain chemical changes, comprehended under the term vinous or alcoholic fermenation, the sugar being changed into *alcohol* and *carbonic acid* gas.

When yeast is added to flour (which we have seen contains sugar), it induces by its presence the sugar to change into *alcohol* and *carbonic acid;* the latter, in its efforts to escape from the dough, distends it, forming vesicular spaces in its interior, and so causing it to become porous and light.

The alcohol during the baking almost entirely escapes from the loaf. During the fermentation, a certain portion of the starch of the flour becomes converted by the action of the yeast into sugar, and in its turn is converted by the yeast into carbonic acid and alcohol.

During baking, part of the starch is converted into gum. We remarked, in a former part of this article, that flour of wheat contains a *much* larger proportion of *glutine*, or vegetable fibrine, than the other cereals. Now the property mentioned before, possessed by crude gluten of wheat, viz., that of elasticity and tenacity, and holding of gas bubbles, is due solely to *the glutine* it contains.

Other cereals which contain but a small percentage of *glutine* will not make light bread.

During the process of baking the bread, most of the yeast cells are destroyed by the heat; a few remain in the bread unchanged, and are capable of exerting their specific action when brought in contact with sugar in solution.

Some physicians are of the opinion that the presence of yeast cells imparts injurious properties to bread, and that like other fungi they produce injurious effects upon the human system. This is the writer's opinion.

The following appeared in the *Engineering Review*, London, England: "It has lately been proved that under certain conditions yeast may be a powerful poison.

"If introduced in suspension into the circulation of living animals to the extent of more than two grammes, it always produces fatal results; in smaller doses it induces coma.

"This is due to the fact that it multiplies in the blood, depriving the red corpuscles of their oxygen, and reducing their color to dark brown."

FUNGI.

The fungi belong to the lowest type of vegetable existence. They are for the most part microscopic in size. Unlike the higher order of plants, they are developed in darkness, and depend on decaying or decomposing organic matter for the material of their growth. They differ from flowering plants in their chemical influence upon the air. Like animals, they absorb oxygen, and give out carbonic acid. Besides organic decomposition, they require for their development a certain degree of heat and moisture in order

FIG. 7.—REPRESENTS YEAST FUNGI PENICILLIUM.

to their vegetative activity. They all contain a large percentage of nitrogenized matter, making their composition more analogous to animal matter than to the higher order of plants. Their growth and maturity are usually rapid, requiring often but a few hours. They are also equally rapid in their decay. The odors they emit are like those of animal matter. Their texture is woody in firmness. Each grows upon its own favorite place or soil. The yeast plant (penicillium) grows in such substances as furnish albuminoids.

The greatest sanit..rian history gives an account of (Moses) forbade the Jews the use of yeast-ferment in bread made and used in their religious services. For further information in regard to the fungi that produce deleterious influence on the human frame, the reader is referred to the following articles by Dr. J. H. Salisbury, A.M.: "Something about Cryptogams, Fermentation, and Disease, *St. Louis Medical Reporter*, Feb., 1869; "Defective Alimentation a Primary Cause of Disease," *St. Louis Medical Reporter*, March and April, 1868; "Remarks on Fungi, with an Account of Experiments, showing the Influence of the Fungi of Wheat and Rye Straw on the Human System," *American Journal of Medical Sciences*, July, 1862; "Additional Observations, relating to the Influence of Fungoid Growth in producing Disease, and in the Fermentation and Putrefaction of Organic Bodies," October, 1862.

UNFERMENTED BREAD.

There are two kinds of unfermented bread. In one, substances are used (different baking powders) in place of yeast, from which a gas (carbonic acid) is evolved, distending the dough, and rendering it vesicular and light.

AERATED BREAD.

The other consists in charging water with carbonic acid gas, and mixing the flour in a close vessel with the water so charged, and baking the resulting dough.

The last process described above has all the advantages possessed by the other for making dough light and porous, without the disadvantage arising from the addition of foreign substance.

But there is one disadvantage attending the process, viz., it cannot be rendered available for domestic bread making.

* A popular treatise on alimentary substances, by A. T. CUZNER, M.D., author of "Food Fishes of the United States," "The Cyclops," and other papers.

BAKING POWDERS.

Among the many baking powders examined by the writer, the "America" was found to be the best.

In its mechanical operation of making the dough porous, it was found to be all that could be desired.

It is composed of an acid phosphate, ammonia, and Natrona soda. It adds to a white flour the phosphates lost in the milling process.

INDIA-RUBBER OR CAOUTCHOUC.

IN consequence of the great demand of late years for India-rubber or caoutchouc, a considerable amount of attention has been given to discover or develop new sources of this useful article, some of which promise to be productive of valuable results. The time is not so very long since when India-rubber of commerce was obtained only from one plant, and that plant the *Siphonia elastica*, as it was then called, but which is now known as the *Hevea brasiliensis*, and which yields what is known in trade at the present time as Para rubber, a quality which holds its own for superiority over all others of the numerous sources from whence the elastic gum is obtained.

In consideration of the great and increasing value of India-rubber, it may not be out of place to sketch the history of the substance from its introduction into this country at the latter end of the last century. In the preface of a work treating on the art of perspective, published about 1770, we find the author thus speaking of that which is now an accessory to every inkstand: "I have seen a substance excellently adapted to the purpose of wiping from paper the marks of a black lead pencil. It must, therefore, be of singular use to those who practice drawing." The writer then goes on to state where it could be procured at that time, which was apparently at only one place in London, and the price was three shillings for a "cubical piece of about half an inch," which, he adds, will last for several years.

The form in which Para rubber was formerly brought to this country was alone sufficient to arouse a curiosity as to its origin. Caoutchouc made its first appearance among us in the well-known grotesque figures of birds and animals, which were not by any means true to nature. No information, however, could be elicited for several years as to its origin other than that it was a vegetable product. The first accurate information was obtained by a French geographical expedition, which, not confining its attention merely to the purposes for which it was organized, cleared up many other difficult points connected with natural history. These observers reported the discovery of great numbers of trees known to the natives as the Hevé, which yielded a large quantity of an elastic, gummy substance, identical with the caoutchouc which had been imported into Europe some years previously. The India-rubber of commerce is now, however, as we have before said, furnished by many plants totally distinct from each other, and though a great deal has been done of late to clear up the nomenclature of many of them, there are others still that are but imperfectly understood.

The Para rubber, which has been imported in such large quantities that the supply has been getting scarce for some years past, is furnished by *Hevea brasiliensis*, though several other allied species, such as *H. spruceana*, yield rubber more or less abundantly. Wallace tells us that the principal caoutchouc district lies between Para and the Xingu River, the trees being among the largest denizens of the neighboring forests. They average about 100 feet in height, and two or three feet in diameter. The tree bears a fruit about the size of a large walnut, divided into three one seeded lobes, which separate or split naturally when ripe. The seeds are mottled and shining on the outside, and are similar in shape and appearance to those of the castor oil, but much larger. They are said to be poisonous when raw, but quite harmless when boiled. The Macaws, however, devour them greedily in their raw state without experiencing any harm. The tapping of the trees and the collection of the caoutchouc have been so often described that it is needless to enter upon it here. In tapping, however, it may be remarked that the first wounds are always made at the uppermost part of the trunk, by which means the juice is drawn off down to the point of incision, after which another wound is made lower down and exhausted, and so on until the base is reached.

Perhaps the next most important of American sources of rubber is *Castilloa elastica*, a plant closely allied to the bread fruit tree, and known as the Central American or Guatemala rubber tree; then comes the Pernambuco rubber from an apocyneous tree (*Hancornia speciosa*), an order which, besides producing Borneo rubber, has recently revealed many rubber yielding plants, not only in the East, but also in Africa both on the East and West Coasts. The Eastern plants are referred to species of *Willughbeia*, *Leuconotis*, and *Chilocarpus*, and the African to various species of *Landolphia*, the principal West Coast species being *L. owariensis* and *L. florida*, which last species also extends to the East Coast, the other East Coast species being *L. kirkii* and *L. petersiana*. The careful cultivation and distribution of any of these plants is a matter of great commercial importance, and we are pleased to direct the attention of planters to our advertising columns, where, among new commercial plants, those yielding India-rubber have a prominent place.

CRYPTOSTEGIA GRANDIFLORA.

Our readers will recollect that about three months ago, a gentleman from South India recognized a plant of this rubber-yielding creeper, growing in Mr. Christy's hot house, as identical with one he had raised from seed in his compound at Tuticorin, for the sake of its beautiful flower. It had thriven luxuriantly in poor sandy soil within a few yards of the sea, and spread so rapidly as to give some trouble in keeping it within bounds. It had never occurred to him before that it was of any economic value, but upon making the discovery above mentioned and obtaining from Mr. Christy directions for the collection of the juice, instructions were sent out to make experimental incisions in the stems of the plants, and to forward here for report and valuation specimens of the produce. These have now come to hand, and the result is most satisfactory and encouraging. The rubber is pronounced by experts to be clean, firm in texture, and of good quality, worth from 2s. 9d. to 3s. 3d. per pound. Now it is hardly necessary for us to point out the significance of these facts, or the wide field that is thus opened up for the profitable employment of capital and labor. There are thousands of acres of waste land in the low country of South India and Ceylon, where it is certain that the *Cryptostegia* will grow almost without any cultivation, and the original outlay would therefore be very trifling, as the land can be had for a nominal price, and all that is necessary seems to be the construction of a rude fence on which the creeper could climb. It grows so rapidly that some return would probably be obtainable in the second year. The cost of collection is still an open question, but as the work could easily be done by boys and girls, and such labor is very cheap, there ought to be an ample margin of profit. We expect to hear before long of experiments on a considerable scale in both the countries named by us.—*Planters' Gazette.*

MUSK.

MUSK is a secretion of the musk deer (*Moschus moschiferus*), which inhabits the alpine regions of the northern provinces of Thibet, and is also found in the southern borders of China and in Siberia as far as Lake Baikal. According to recent reports, it has been found in the provinces of Fohkien and Kiangsi, but does not seem to be hunted there.

The pouch that grows on the belly is about 2½ inches long, 1⅓ in diameter, and weighs about 30 grammes (over an ounce). It must be cut off as soon as the animal is dead, tied up, and dried. On the interior walls of this pouch is the musk, which looks like snuff, and which, if unadulterated, consists of smooth dry particles having a greasy feeling, is very friable, of a reddish brown color, and has the peculiar and unmistakable odor.

There are two principal varieties, Tonquin and Yunnan musk. The former comes from Thibet and Szechuen, the latter from the province of Yunnan, and both kinds find their way to Shanghai through Chunking and Lankow.

In addition to the ordinary Tonquin and Yunnan there is a finer grade of each distinguished by adding the term Taupi, thus Tonquin-taupi and Yunnan-taupi, which signifies the musk without the skin, otherwise the pouch is included. Both grades have an extremely fine perfume and bring a much higher price, but find little use in Europe. The odor is perceptibly different from the common ware, hence it might be supposed that they were derived from a totally different animal or came from another region.

A third sort is the Cabardine or Russian musk from Tientsin. Its perfume is not nearly so fine as that from Tonquin and Yunnan, and the loss from hair, skin, and moisture is much greater, hence its value is much less. Tonquin musk is the one chiefly exported to Europe and America. Cabardine musk is less esteemed there, and Japan is the principal market for the Yunnan musk. In the first half of 1882 Japan took 340 catties of this musk.

For some time past there has been a marked decrease in the quantity of Tonquin musk received. The Chinese dealers attributed this to the establishment of a protective law in the hunting section. This circumstance combined with active demand in London and a small supply on hand caused the price to rise from 71 or 72 taels per catty in 1881 to 120 taels in 1882. (The Shanghai tael is $1.15, and the catty weighs 1⅓ lb. avoir.) This hunting law is said to have been removed recently, but no change in price nor increase in receipts has yet been detected.

If some limit was actually put upon the musk hunting in Szechuen and Thibet, at all events Yunnan did not follow the example, for the receipts from this province are always abundant, so that the total export of musk seems but little less than last year. Independently from the fact that the price of Yunnan musk has followed that of Tonquin musk, the large production of the former has had little influence upon the business in Europe, where neither sort has increased in favor nor in consumption.

The Chinese firms that deal in musk have, as a rule, branch houses in the chief cities of Yunnan and Szechuen, and in Chungking, Zchang, and Lankow. They advance the money to the hunters upon the musk and thus prevent the article from falling into other hands than those of regular dealers. Every large musk firm has agents in Shanghai and Canton to look after the sales. In Shanghai there are only five "hongs" for Yunnan and Tonquin musk; they all live in the same neighborhood, and there is no competition between them, as they form a kind of monopoly.

The business in other articles of export is done by brokers, or middle-men, who are foreigners and who carry samples of newly received products around to their customers, but with musk this is not the case.

Here the buyers must seek some other means of informing themselves when a new "chop" comes in, and the musk dealers seek to secure themselves from being too quickly deprived of their wares. Musk is sold here only in the original chests of 10 to 30 catties (averaging 20 catties), or in whole "chops." The buyer does not have his choice of the individual bags, cannot divide a chop, but must either take the original consignment just as it comes from the interior, or refuse it all. There is no particular season for musk; it comes into the market at irregular intervals throughout the entire year. The Carbadine musk brought from Tientsin is sold by special "hongs"

The export of this drug will always remain within moderate limits, not only because the production is limited by nature, but also because the Occidental demand has as competitor the still stronger demand for home consumption. It is well known that in China everything smells of musk. Both sexes are accustomed to carry it with them in little boxes and to keep it in their clothes presses. While it is losing ground in European therapeutics, the cures attributed to it in China are very manifold, as may be supposed from their mythical nature.

When we consider that an export of 3,000 catties, each catty containing 15 to 20 pouches of Yunnan, or 20 to 30 of Tonquin musk, means the sacrifice of no less than 60,000 musk deer, and this quantity has been reached several times of late years, and then if we add to this the consumption in China itself, which can scarcely be estimated, we see that it is not too much to fear the entire extirpation of this useful as well as graceful animal. Hence it would be desirable that the before mentioned rumor of the legal establishment of a period of protection should be confirmed, even if the development of this branch of trade should suffer some in the immediate future.

The adulterations of this ware seem to be as ancient as the trade itself. Du Halde mentions it as being very common and refers to pulverized rotten wood as one of the ingredients; and he also speaks of artificial pouches with which they avoided the law then in force against selling musk to foreigners. At present really pure musk scarcely comes in the market at all. Even the best chops do not contain more than 50 or 60 per cent. of genuine substance, and on the average we must be satisfied with about 30 per cent.

The adulterants of musk are generally coagulated blood, a fatty earth (or ocher), paper, hair, pieces of leather, etc., which are introduced into the bags so skillfully as to require a sharp eye and years of experience to be able to detect it. It is not customary here to make any chemical test; the musk inspector takes out a little of the substance with a silver needle, notices its odor, and estimates its value. The pods or bags are immediately assorted according to the percentage of adulteration that he thinks he has discovered in it, and put in piles called 1, 2, and 3, for the European or American market, where this classification is frequently changed and others substituted.

Each pouch is then wrapped in Chinese paper and put in a pasteboard box lined with lead, and covered with silk. Each of these boxes contains a catty of musk; they are finally put in a wooden box lined with zinc. These boxes are of different sizes according to the size of the chop to be packed. They are generally shipped by the mail steamers, being placed in the safe reserved for bullion and treasure. These precautions are necessary on account of the high price of the goods as well as liability to evaporation. The ships of the old East India Company are not allowed to take any musk on board.

The total export for the last five years was 25,664 catties, or 33,875 lb., valued at $2,728,800. The chief port of export is Tientsin; Shanghai and Canton export very little.—*From the Report of the German Consul-General in Shanghai.*

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TABLE OF CONTENTS.

PAGE

I. ENGINEERING.—The Great Garabit Bridge, France, with dimensions, description, and two engravings 6231
Forbes' Rigs for War Ships, as presented to the Boston Branch of the Naval Institute.—With eight illustrations 6232
The Use of Coal Gas as a Means of Ventilation.—By NORTON H. HUMPHRYS. A useful and excellent paper 6232
Rolling Mill Engines.—Two large engravings 6235
A Paper Steam Launch 6235

II. DECORATIVE ART.—Sketches from the Furniture Exhibition, London.—Numerous figures 6236
Sheraton Furniture.—Several figures 6236

III. TECHNOLOGY.—Projecting Lanterns.—By C. H. STOWELL 6237
Photomicrography without a Microscope or Microscopic Objective.—1 figure 6238
Laboratory Filter Press for Retaining the most Finely Divided Precipitates.—By JERVIS EYRE FOAKES.—Several figures 6238
Artificial Fuel 6238
Photographic Action Studied Spectroscopically 6239

IV. ELECTRICITY AND MAGNETISM.—De Combettes's Rheostat.—1 figure 6239
Exhibition of Accumulators in the Halls of the Society d'Encouragement, Paris.—1 illustration 6239
Deviations of the Compass on Iron Vessels.—How caused and how prevented 6239
The Motions of Camphor upon Water and Mercury.—3 figures 6240
Electric Flannel 6240

V. MEDICINE AND HYGIENE.—The Cerebral Origin of Dental Decay 6240
Cereal Foods from what we Eat and what We Drink.—By Dr. A. T. CUZNER.—White flour.—Dark flour.—Best flour.—Bread making.—Yeast.—Fungi.—2 figures 6241

VI. NATURAL HISTORY.—India-rubber—Caoutchouc 6243
Musk.—How obtained, preservation, treatment, value, trade, statistics, etc 6242

VII. INDEX OF THE SCIENTIFIC AMERICAN SUPPLEMENT for volume xv., numbers 366 to 391, inclusive, being from January, 1883, to July, 1883 6244

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The Scientific American Supplement. Index for Vol. 15.

JANUARY—JUNE, 1883.

The * Indicates that the Article is Illustrated by Engravings.

A

Absorber for waste-water.....*6091
Acclimation of bamboo.....5942
Acid, benz'c and boric, in milk 6051
Acid, caffeic, in cuprea bark . 6060
Acid, carb., and carb. bisulph. 6191
Acid, carbonic, antisep. prop.. 5987
Acid, boracic, is it poisonous?. 6225
Acid, fluoric.....6065
Acid, oxalic.....6209
Acid, prussic, in cassava 6051
Acid, sulphuric, apparatus.....6051
Acid, uric, synthesis.....*5845
Acrocliniun roseum.....6239
Accumulators, exhibition of...*6239
Adulteration of essent. oils ... 5859
Adulteration of olive oil.....5876
Avertising, Eng and Amer... 6214
Aerial navigation.....5993
Alcoholic habit, the.....5860
Africa, exploration, De Brazza. *5895
African discoveries 5974
Ague plants and allies.....*6068
Ague urine, crystals in.....*6117
Air, bacteria in the.....5986
Air compressor, ventilating...*6221
Air, effect on seeds 5958
Air, dialysis, oxygen from.....*5859
Air, obstructed, discoveries in 6193
Alarm, morning, electric *5979
Alaska.....5847
Albumen, commercial 5889
Albumen, delicate test for.....5859
Alcohol in health 6082
Alcohol, solidification.....6158
Alizarine blue, soluble.....6081
Altar, marvelous, Heron's.....*6087
*6137
Alternating current machine..*5874
Allegory, a stage 6099
Alloys, explosive.....6080
American Museum Nat. Hist.. 6004
Ammonia in gas, removal.... 6190
Ampere-meter, Blyth's.....*6206
Amphitheater, Roman, Arles..*5989
Analyses of food.....5846
Analysis of milk, apparatus....*6016
Analysis of plant fiber 6017
Angular motion in wind storms 6208
Animal waste, utilization 5896
Animals, curious facts 6101
Animals, dom., color-marking. 6181
Animals, speech in.....5940
Animals, winter sleep of 5940
Anthracene from petro. res ... 6209
Anthracene, sensitive to light. 5985
Anti-fat remedy, new.....5846
Antiseptic substances.....6205
Antwerp waterworks *5980
Apatite, Canadian 6182
Ape, nose.....*6212
Arc, elect., in vapor sulp. carb. 5907
Arc, electric, reaction current. 6036
Architecture, Amer., ideas on. 5904
Architecture, color in.....6077
Archil, substitute for 6118
Architecture, suggestions in, *5841, *5934, *5950, *6029, *6112, *6125, *6152, *6190, *6202
Armature, external, machine..*6173
Armature, step w'd, Crompton*5982
Art, decorative, suggestions, *5904, *6112, *6175, *6190
Artesian wells, Australian.....5981
Artillery experiments, Spezia. *5950
Asbestos filters.....6063
Asparagus, notes on 5909
Asparagus on French system. *5909
Aspirato-condenser, Koerting's*5996
Assays, gold, boiling app *6081
Astigmatism and ophthalmo..*6114
Astronomy for 1883.....6054
Aurora borealis, the.....6062
Aurore borealee, theories.....*5927
Auscultation, cephal., men.dis. 6083
Australia, gold-bearing rocks.. 5924
Austral, steamer, sinking.....*5933
Automatic telegraphy.....*5868
Autopsy table, new.....*6132

B

Bacill, tubercle, in sputa..... 6145
Bacteria in soil and air.....5986
Bagging scales, Paupier's.....*5855
Balance, magnetic *6154
Balancing of machinery.....*5807
Balloon exhibition, France.....5990
Ball-valve, improved *5931
Bamboo, acclimation of.....5942
Barometer, registering *6042
Barge, transportation, lake 6028
Bark, cuprea, caffeic acid..... 6060
Bark of U. S. trees, tannin in. 6001
Bar transmitter.....*6110
Bat, winter sleep of 5740
Battery cell, improved *5856
Battery, chloride silver *6141
Battery, insulite.....*6218
Batteries, nit. and chrom. acid 6080
Battery, secondary 5907
Battery, photo-electric, new... 5950
Batteries, storage 6171
Batteries, storage, Edison on.. 5998
Beans, broad Windsor.....*5908
Bears, winter sleep of.....5941
Beton cement reservoir *6186
Bee culture in India.....6019
Bee ranches, California *6106
Beer consumption statistics.... 6063
Beetle, rare, ravages *6196
Beetles, hollyhock *5891
Beet root molasses, apparatus. *5996
Bell and battery, electric.....*5889
Bell, electric, round *6091
Bell, trial galvanometric *6079
Bell, vibrating, Lippens' *6189
Benzoic acid in milk.....6051
Bichromate pot. stains, remov. 6158
Bile pigments, reactions..... 5910
Bird, snake, the 6103
Bird tracks, ancient 5956
Bird, tropic, home of.....*6104
Bismuthic hair dye.....5890
Black Cañon, survey.....6133
Black Country, nailmakers in. 5998
Blacking, glycerine 6064
Bladder, suture of the.....5877
Blast heat measuring app.....5812
Blasting work in Danube.....6087
Bleaching apparatus, Morris'..*5949
Bleaching process, new. 6148
Blistering of paint 6175
Blood, ague plants in *6116
Blood, tubercular matter in... *6194
Blue, alizarine soluble.....6082
Boat, fast, Pictet's *6139
Boat, life, reversible.....*6011
Boats, new form for.....6058
Boats, torpedo.....*6139
Boatswain bird, home of.....*6104
Boiler explosions.....6023
Boiler explosion, Cincinnati..*5998
Boiler feed apparatus *5975
Boiler, tubular, Heron's.....*6087
Boilers, scale in, prevention.. 5976
Boilers, steam, safety app....*5975
Boiling appar. for gold assays.*6081
Bone-black for superphosph.. 6033
Boracic acid, is it poisonous?. 6225
Boric acid in milk.....6051
Bottle-nosed whale oil 5942
Boxes, magic *6211
Brain health 5861
Brain, muscle vs.....6225
Brain, steel blade in.....6032
Brain-weight of Gambetta 5909
Brain work and hand work 6159
Brain work, unconscious.....5948
Bread making.....6241
Bread ovens, improved *5916
Breathing, influ. of effective, 6170, *6192
Breathing power, development*6193
Breech-loader, 100 ton, trial...*5960
Brewing appliances, Cave's... *5899
Bridge, Albula, Switzerland.... 6201
Bridge, swing, Hamburg.....*5978
Bridge, Tay 5948
Bridge, Queen's Ferry 5948
Bridge, suspen., Monongahela. 6201
Bridges, care and maint'ance. 6167
Bridges, longest in world. 6202
Bridges, vibrations in *6071, *6206
British Columbia, climate..... 6021
Brussels Commercial Museum 5898
Bridge, railway, Indus *6071
Bridge, railway, Kinzua *5880
Bridge, railway, St. Leger Val *6008
Bridge, foot, La Villette. *6072
Bridge over Atchafalaya.....*6168
Bridge, East River.....5948
Bridge, East River, painting.. 6044
Bridge, the Garabit *6231
Buc, potato, medical prop.....5890
Building for Victoria Regia....*6164
Building mat., destruction....*6182
Building stones, decay of..... 5934
Buildings, safety-appliances.. 5980
Burner, carbo-oxyhydric..... *6111
Bust, the isolated.....*6230

C

Cabinets, magic *6211
Cable roads, Chicago *5850
Caffeic acid in cuprea bark.... 6060
Calcite, artific., production 5844
Calcutta exhibition 6162
Calico printing, sulphocyan.... 6113
California quicksilver.....5942
Calumet mine, standpipe *5915
Camera, gun, Sands' *6205
Camera lucida, Grunow's.....*6061
Camphor, motions on water...*6240
Canal, Morris, inclined planes*5943
Canal, Panama.....5948
Canal, Panama, line of *5853
Canal, Panama, progress.....6200
Canal, ship, Manchester.....*6107
Canal, Suez 6075
Cancer and alluvial soil.....5954
Candle, extinguishing *6195
Cañon, Black, survey 6133
Cantharidin in potato-bug 5890
Canned meats.....6148
Canned vegetables, greening.. 5949
Caoutchouc 6242
Carbo-oxyhydric burner.....*6111
Carbon.....6148
Carbon, am't wasted as soot 6176
Carbon, bisulphide 6095
Carbon lantern transparencies 6113
Carbon, sulph. electr. arc in.. 5907
Carbon sulphide, solidif 6158
Carbonic acid and carb. bisul. 6191
Carbonic acid, antisep. prop.. 5987
Carbonization app., beet root.*5996
Carbonizing app. for rags *6029
Carding machine, new *6056
Car, dynamometric, French .. *5980
Car, street, electric *6111
Car-wheels, balancing.....*5869
Cars, dissem'tion of moths by. 6103
Cars, running gear for *6059
Cartoons in glass *5904
Cascade saturator.....*5931
Cassava, prussic acid in 6051
Castings, iron, ornamental.....*5849
Casts, new material for 6029
Cathedral, St. Paul's.....*5965
Cell for battery, improved.....*5856
Cellar slug, the *5925
Cellulose, fermentation.....6158
Cellulose, oxidation of.....6017
Cement, a natural.....5892
Cement, glycerine as a.....6064
Cement, Portland, manuf.....6155
Cement reservoir.....*6186
Cereal foods *6224, *6241
Cerebral origin dental decay... 6240
Chain transmitter, the.....*6110
Channel steamer, launch of.... 5998
Channel tunnel, machine *6044
Chava fragilis *6240
Chemigraphic engraving.....5903
Chemical react., gum arab. in. 5844
Chemistry, industrial, papers. 5967
Chemistry of hops.....5953
Chemistry of liquification..... 6016
Chemistry, organic, teaching.. 5936
Chemistry, technic., instruc.. 5844
Chiccory, large-rooted *5942
Chickens, Amer., for Europe.. 5954
Chimneys, draught of 5885
Chloroform, testing for.....5957
Chippendale furniture.....*6199
Chrysanthemum culture.....6085
Church, Temple, organ at.....5908
Churning with the wind *5878
Circulator, continuous *6205
Civil engineering, training in.. 5865
Clays, character of.....6112
Climate of Alaska.....5848
Clip for tentering machines.. *5984
Clock, historical *5993
Coal-dust in mines, effect..... 5970
Coal formation, physical cond. 6104
Coal gas, hydrogen sulp. from *6129
Coal gas in ventilation..... 6232
Coal hauling, revolution in... 5848
Coal mine, deepest American . 6061
Coaptation, suture-clamp.....*6210
Cod-liver oil, value.....6193
Coffee, green, colored 6158
Coffee tavern, Newark, Eng... *5941
Coinage, nickel 5874
Coke furnace, Siebel's.....*6074
Cold, apparent radiation..... 5908
Cold, radiation of.....5919
Cold, radiation of.....5982
Color in architecture.....6077
Color-markings in animals.... 6181
Color of water.....6150
Colors, perception in darkness. 6209
Coloring matter, new.....6118
Columbia, British, climate 6021
Columbus, statue of, new....*5847
Comet of 1882, in India *6105
Comet's head, the.....*5862
Comparative zoology, lesson.. 5861
Compass, deviations of the ... 6239
Compensator for saccharim....*5962
Compound engine, Farcot's...*5841
Compound engine, Sulzer's...*5961
Concrete in marine work *6169
Condenser, aspir., Koerting's..*5996
Conductors, electr., lead-cased*6153
Conduits, wat., regulating app*5931
Congress of German surgeons. 5877
Consumption, mullein in 6179
Consumption, prevention 6176
Contacts, microphonic *6205
Controlier magnet, Thomson..*6188
Copying letters, process for... 5965
Copper, tellurium in.....6022
Corn 5878
Corn silk preparations 6210
Corona, solar, photographing. 5930
Corthylus punctatissimus.....*6196
Corrosive, chem., electrol. bal. 6079
Corrosive sublimate.....5877
Cottage, woodman's, England.*6112
Courts of justice, royal *5970
Cozzing mill engines, improv..*6234
Creosote, report upon.....5876
Creosote, tests and action 5876
Crew, rescue, Heard Island....*6099
Croton water, objects in 6131
Crow, the *6149
Cryolite, locality, new 5910
Cryptostegia grandiflora.....6242
Crystals, quartz, explosion of. 5924
Cucumber wood 6199
Cultivator, steam, new *5963
Culture of lilies.....5957
Culture of small fruits 6163
Cuprea bark caffeic acid from 6060
Cursometer, the.....*5932
Currant-bud disease *5891
Current dynamometer *6171
Current meter, Hopkinson's ..*6079
Current, reaction, electric arc. 6026
Current regulator, Thomson...*6188
Cypripedium sedeni.....*6019
Cyptogams on human body ... 6052

D

Dam across Ottawa River.....*6121
Danube, blasting work in 6087
Dark-room windows, tissue for 5936
De Brazza, Savorgnan *5895
Decorative art, suggestions .. *5904
Declinometer, the.....*6154
Della Robbia, Luca 5965
Dental decay, cerebral origin,. 6240
Deprez, Marcel.....*6207
Derailment of railway train...*5894
Derrick, hand, 30-foot *6059
Desk knapsack.....*5884
Deutzias.....6053
Developer, new, for gelat. pits. 5858
Devil's pit, the.....6021
Dialysis of air, oxygen from....*5859
Digestion of food.....6176
Dioscorea retusa.....*6196
Dip-circle, simple *5919
Diphtheria, iodoform in.....5954
Diphtheria, treatment. 5890
Dipping needle, discovery of..*5843
Discoveries, African.....5974
Distilleries, press for *5973
Dock, floating, St. Nazaire ...*5995
Dock, graving, Port Lyttleton.*6167
Dock works, Alexandria.....5948
Doré, Gustave *5988
Doubling arrangement for flax.*5854
Draper, Henry 5987, *6041
Draught of chimneys.....5885
Dress for milliuones, model...*5983
Dressmakers, lead poison'g in. 5954
Drier, lumber, Excelsior.....*5981
Drill, rock, percussion *5882
Drinking horns, Heron's.....*5972
Dusts, dangerous properties... 5969, 5984
Dwelling houses, hints on.... 6123
Dwelling, mansard roof.....*6125
Dwellings, country, cheap *6174
Dye, hair, bismuthic.....5890
Dyeing, fire risks of.....6001
Dyeing, glycerine in 6064, 6223
Dynamo machine, Ferranti...*5474
Dynamo machine, Elphinstone*5888
Dynamometer, Ayrton & Perry's *5932
Dynamometer, current.....*5997
Dynamometer, totalizing.....*5997
Dynamometic car, French....*5980

E

Eclipses during 1883 6084
Education, Huxley on 6084
Egg and poultry trade 5954
Eggs, app. for hatching. *6058
Elba, tunnel under.....*6057
Electric alarm, an *6079
Electric arc, reaction current.. 6026
Electric arc in vap. sulp. carb. 5907
Electric battery, photo, new.. 5950
Electric bell and battery *5889
Electric bell, Lipper's *6189
Electric bell, round.....*6091
Electric conductors, lead cased.*6153
Electric current, meter, new..*6079
Electric distribut. power.....6109
Electric flannel 6240
Electric illum. by reflection.. 6063
Electric lamps, small *5907
Electric light, Paris sewers ...*6153
Electric light on vessels.....6189
Electric light, Thomson-Houst.*6188
Electric light, eff. on plants.. 6026
Electric light, pressure indic . 6171
Electric light measuring app..*6170
Electric light speculations... 6026
Electric light'g syst. und'g'nd,*6220
Electric light'g, teleg. office. *5919
Electric machine, Elphinstone*5888
Electric mach'e, extern. armat.*6173
Electric machine, Ferranti ..*5874
Electric phenom. simulation..*6217
Electric railway, Portrush 6187
Electric railway, subterranean*6025
Electric street car, new.....*6111
Electric tram car, new *6092
Electric tram., Portrush, cost.. 6206
Electric telegraph, history...*6125
Electric tricycle, the *5857
Electric underground system..*6219
Electrical ships' loge *5842
Electrical transmission.....6127
Electricity, applications.....6093
Electricity, domestic *5856
Electricity, heat, and light.... 6048
Electricity in gold mining.... 6093
Electricity, influ. of vacuum..*6091
Electricity on tramways.....*6092
Electricity, propelling power.. 5876
Electricity, static, conversion. 5867
Electricity, static, trans..... 5875
Electrolysis, extract'n met. by 6016
Electrolysis in dcter. of lead ..*6209
Electrolysis, new experiment in*6080
Electrolytic bal. chem. corros. 6079
Electrometer, quadrant *5014
Electromotive force.....5907
Elevator, grain, Memphis *6203
Elevator, grain, Watson's....*6203
Elevators, grain.....6073
Ellipses, turning in lathe..... 5916
Emulsion for opal printing 5859
Emulsion, gelatine, process...*5966
Emulsion, gelatino bromide 6189
Emulsion, gelat., silver iod, in 5842
Empusa and Mantides.....*6149
Enamel photography.....6094
Enameling 6175
Engine, compound, Farcot's..*5841
Engine, comp., Woolf *6183
Engine, horizontal, Sulzer's ..*5961
Engine, steam, origin *6087
Engines, cozzing mill, improv.*6234
Engines, rail mill *6235
Engineering, civil, training in. 5865
Engineering works, recent.... 5948
Engraving, chemigraphic 5903
Engraving, photo, improved.. 5842
Enlargements on gelat. plates. 5950
Ensilage, silos and.....6033
Envelopes, magic.....*6211
Eolopile, Heron's *6087
Equalizer, photo light.....*6000
Essence bouquet, recipe 6067
Etna, eruption, recent.....*6195
Ether waves, doctrine, review, 5983, 5999, 6015
Eucalyptus-tree, the 6095
Evaporating apparatus, new ..*6186
Evolution of American trotter. 6102
Exhibition of accumulators...*6239
Exercise, physical 5890
Exhibition, balloon, France.. 5990
Exhibition, Calcutta.....6162
Exhibition, Fisheries, London*6136
Exhibition, furniture, London.*6236
Exhibitions, scientific *6211
Explosion of quartz crystals.. 5924
Explosion, boiler, Cincinnati..*5998
Explosions, boiler 6023
Explosive alloys.....6080
External armature machine ..*6173
Extract, fluid, of corn silk..... 6210
Extractor, logwood *6204
Extractor, Schorn's *5953
Eye-glasses 6161

F

Fabrics, rubber, loom for....*6221
Fan, a new *6057
Fastest records, the 5972
Feed apparatus, boiler *5975
Feeding, forced, in phthisis .. 5890
Fermentation, fire risks.....6001
Fermentation of cellulose..... 6158
Fertilizers, home-made.....6083
Festival, a, 80 years ago.....5955
Fever, intermittent, pathol. ..*6116
Fever, typhoid, curability..... 6007
Fever urine, plants in.....*6116
Fevers, cryptogamic origin.... 6052
Fibers 5922
Fibers, plant, analysis of..... 6017
Filaria disease.....6052, 6133
Filter press, laboratory *6238
Filters, asbestos 6063
Filters, spongy iron.....5980
Fine arts, palace, Rome.....*6013
Fire-engine, steam, English ..*5914
Fire escape, folding *6220
Fire proof towns, River Plate.. 6300
Fire risks of malting, etc..... 6001
Fires, forest 6088
Fires, recent, their lessons... 5924
Fish, Malacosteus niger *6104
Fishes, Cuban 6136
Fisheries Exhibition, London.*6136
Fisheries of Japan 5941
Flannel, electric 6240
Flame, luminosity of.....6141
Flax, doubling arrangem. for.*5854
Floating dock, St. Nazaire....*5995
Flour, action of sun on 6235
Flour, wheat, analysis 6241
Florida, gulf coast of *5923
Flour mill, porcelain cylinder.*6007
Flowers in winter quarters 6003
Flowers of mummy garlands.. 5973
Flowers of Pernettya *5957
Flowers, perfume, extraction.. 6064
Flowers used in perfumery 6066
Fluke, liver, life history *6228
Fluoric acid 6065
Flushing appar., intermittent. *6091
Flying 6091, 6186
Flying machines.....5914
Focus of lens, to ascertain....*6142
Food, analyses of.....5846
Food, digestion of.....6176
Food, preserv., glycerine for.. 6065
Foods, cereal *6224, *6241
Foot-bridge, La Villette.....*6072
Foot-prints, human, in rock... 5846
Foot-prints, human, in stone.. 5974
Force, electromotive.....5907
Force and motion, difference.. 6048
Forest fires 6088
Forest trees, Canada, limit....*6236
Forum, Roman, at Arles.....*5989
Fountain, circulating.....*6208
Franz-Joseph Land.....6037
Frangipauni, ess., recipe..... 6067
Fruit trees, barren, potash for. 6235
Fruit trees, scale on.....5910
Fruits, how nature sweetens.. 6050
Fruits, small, culture 6163
Fry, Howard *6179
Fuel, artificial.....6238
Fuel, water gas as 6054
Fungi, yeast.....*6241
Furnace, blast, heat of.....6184
Furnace, coke, Siebel's *6074
Furnaces, gas, lighter for.....*5857
Furniture, Chippendale.....*6199
Furniture exhibition, London..*6236
Furniture, sketches of.....*6236
Furniture, Sheraton, ...*6236

G

Galvanometer, simple.....*5918
Galvanom., solenoid, Blyth's.*6206
Galvanometric trial bell *6079
Gambetta, brain weight of 5939
Garabit Bridge, the *6231
Garden destroyer *6100
Garden pests.....*5901
Gas and steam motors, effic... 5864
Gas, coal, hydrog. sulph. from.*6129
Gas, coal, in ventilation..... 6232
Gas engine, Wordsworth.....*6068
Gas furnaces, lighter for.....*5857
Gas, heating by.....*6028
Gas meters, glycerine for *6064
Gas lighter, Loiseau's.....*5857
Gas, removal of ammonia..... 6190
Gas, water, as fuel 6045
Gases, insects in, vitality 5955
Gauze transmitter, the.....*6110
Gear, running, for cars *6057
Gearkeulite, locality 5910
Gelatine emuls. neg. develop't 6118
Gelatine emulsion process *5966
Gelatine emuls., silver iodide. 5842
Gelatine in pill-coating 5909
Gelatine negatives, washing... 6078
Gelatine plates, coating.....*5857
Gelatine plates, development.. 5842
Gelatine plates, developer.... 5858
Gelatine plates, enlarge'ts on. 5950
Gelatine plates, intens .6013, 6095
Gelatine plates, preparation.. 6128
Gelatino-bromide emulsion 6189
Generator, secondary, Gaulard*6172
Generator, Thomson spherical*6188
Geologist, N. J., report 6166
German surg's, rec't congress. 5877
Geyser Water, Yellowstone P'k 6096
Gila monster.....*6197
Gilt wire, preparation.....6029
Girl, the invisible.....*6100
Gladiolus, the 6178
Glass, action, sunlight 6158
Glass case, speaking *6100
Glass, ground, substitutes for. 5842
Glass, pictures in.....*5904
Glass, pictures on 6129
Glass, resistance of 6230
Glass stoppers, fixed, removal. 5908
Glass, window, manufacture.. 5841
Glucose, estima. by glycerine 6064
Gluten, qualities of.....*6225
Glycerine blacking 6064
Glycerine, manufact. and use.. 6223
Glycerine, nitro, properties .. 6051
Glycerine, prep. and uses 6064
Glycerine, tests for 6065
Gold assays, boiling, appar. ..*6081
Gold bearing rocks, Australia. 5924
Gold leaf, preparation 6029
Gold mining, electricity in 6093
Gold, photograph., recovery .*6013
Grain elevator 6073
Grain elevator, Memphis *6203
Grain elevator, Watson's.....*6203
Grain, how elevated 6073
Grain separators, Marot's *6090
Grain transmitter, the.....*6110
Grain warehousing machinery*6024
Grammar school, Heath *5902
Grapevine, a remarkable.....*5973
Grates, ornamental *5849
Graving dock, Port Lyttleton.*6167
Green, vanadium 5849
Greening canned vegetables... 5949
Greygynog Hall, England.....5934
Guano, Australian, analyses.... 5958
Gulf coast of Florida *5923
Gum arabic in chem. reactions 5844
Gun camera, Sands' *6205
Gun, 100-ton, trial at Spezia ..*5960
Gun cotton and nitroglycerine 6064
Gunpowder, chemical theory . 5937
Gum tree, sweet 6105
Gypsum, setting of 6129

H

Hæmatoxyleine and hæmateine 6096
Hair-dye, bismuthic 5890
Hair, its use and care.....6191
Hamburg swing bridge.....*5978
Handkerchief extracts, recipes 6067
Handwork and brainwork.... 6159
Harrison J., chronom. maker . 6030
Harrow for macadam. roads..*6075
Hauling coal, revolution in.... 5848
Hawaiian Isl, volcanic phen... 6101
Hay press, Pilter's *5911
Headache, remedies for..... 6119
Head of the comet *5862
Head, the speaking *6100
Heard Island, rescue of crew .*6099
Heat.....5875
Heat, blast, measuring app 6212
Heat, light, and electricity.... 6048
Heating by gas.....*6028
Heath, Irish, white.....*6094
Hedgehog, winter sleep of 5940
Heliopteram roseam.....*5845
Heloderma horridum.....*6197
Henley, W. T.....5917
Horograph for schools.....*5949
High-speed boat, Pictet.....*6139
Historical clock, a 5993
Hollyhock insects *5891
Hops, the chemistry of.....6053
Hornets and wasps *6100
Horse, American, evolution.... 6102
Horse, drinking, decapitated .. *5973
Horseshoeing, the art of..... 6099
Horses, fastest, records.....5972
Horses, trotting, statistics..... 6090
Horses, wild, in London.....*6164
Hostelry, Newark, Engl.....*5841
House at Heaton.....*6125
House at Reigate *6152
House at Sevenoaks *6152
House of 15th cent., Chartres.*5884
House sanitary appli. ar'nge't *5980
Houses, cheap.....6174
Houses, dwelling, hints on.... 6123
Human footprints in rock 5846
Human footprints in stone.... 5974
Huxley on education 6084
Hydraulic machine tools.....6088
Hydraulic machinery....*5895, 5944
Hydraulic press, new.....*6170
Hydraulic press, how made... *5895
Hydrogen sulph., preparation.*6129
Hygrometer, registering *6042
Hydrophobia, Pasteur on,.... 5938
Hypnotism in Paris.....5902

I

Ice-breaking vessel, new.. 6109
Ice under low pressures.....*6081
Ichthyol 6182
Inclined planes, Morris Canal.*5943
Incubator, improved.....*6058
Inebriety, obscure cases of.... 5877
India rubber 6242
Indicator, for trains.....*6057
Indicator, pressure, elect. light 6171
Indicator, stability, ship.....*6140
Indigo, artificial 5844
Induction spark, thermic phe.. 5952
Indus railway bridge.....*6071
Ink, invisible, new 6209
Ink, lithograph., machine..*6186
Ink, stamping, indelible 5953
Insane, rights of 6160
Insects in gases, vitality..... 5955
Insensibility from want oxy'n. 6159
Insulite sealed battery.....*6218
Integrator, totalizing.....*5889
Intensifier for wet plates 6189
Intensifying gelatine plates.... 6013
Iodoform 5877
Iodoform in diphtheria..... 5954
Iodoform, testing for.....5957
Iron and steel.....6184
Iron and steel process, Bull's.. 6058
Iron, evident magnetism, cause 6216
Ironclad attacked by torpedo.*6138
Iron making, English, progress 6220
Iron ores crystalline, origin.. 6036
Iron, pig, world's product..... 6184
Iron, protection from rust..... 5931
Iron, wrought, production..... 6185
Iridium, note on 5846
Irrigation in N. E. Colorado... 6170
Isthmus of Panama, map. *5852
Ivory, sources of.....5999

J

Japan, fisheries of.....5941
Japanese peppermint.....6196
Japanese soils.....5892
Jockey club, ess., recipe..... 6067
Juniper, weeping blue *6164
Juniperus recurva.....*6164

K

Kangaroo, the.....6198
Kinsua Viaduct.....*5880
Knapsack, desk *5844
Kola nut tree.....5991

L

Lakes, great, transportation on 6023
Lake, pitch, Trinidad 6105
Lamp, arc., Thomson *6189
Lamp, magnesium, Loiseau's..*5982
Lamps, incandescent, small... *5907
Land sink, a 6053
Lantern transparen., carbon .. 6113
Lanterns, projecting.....6237
La Normandie, new steamer.. *5831
Laparotomy in cancer 5877
La Plata, steamer, rudder for. *5977
Larynx, extirpation, treatm't. 5877
Lathe, oval, guiding tool in... *5855
Lathe, screw-cutting *5978
Lathe, turning ellipses in..... 5916
Launch of Channel steamer.... 5998
Launch, paper, steam 6235
La Villette foot-bridge.....*6072
Lead, curious facts about..... 5844
Lead, determ. by electrolysis..*6090
Lead poison'g in dressmakers. 5954
Leather, machine to prepare... *5870
Lens, to ascertain focus.....*6142
Lentil, the.....*5845
Letter-copying, process for.... 5965
Liebig.....*5971
Lifeboat, reversible new.....*6011
Life, progress on earth..... 5955
Life rafts.....6102
Light, electr., Alliser Theater. 6207
Light, electric, on vessels..... 6189
Light, elect., Thom.-Houston *6188
Light, elect., in teleg. office.. *5919
Light, elect, mess. app.....*6170
Light, elect., pressure indicat *6171
Light, electric, speculations.... 6036
Light, electr., effect on plants. 6026
Light, electr., Paris sewers.... *6153
Light, heat, and electricity..... 6048
Light equalizer, photo.....*6000
Light, material nature, docct. 5982, 5999, 6015
Light, standard, phos. tablet.. 5969
Lighter, naphtha, Loiseau's.. *5857
Lighters, Domestic *5857
Lights, intense, photometry... *6047
Lights, photometric measure.. 5907
Lighthouse, Eddystone 5940
Lighthouse, Weser River..... *6055
Lignification, chemistry of.... 6016
Lignose, constitution of..... 6017
Lilies and their culture..... 5957
Limax cinereus.....*5925
Lime, acetate of 6190
Lime-juice, properties..... 5986
Limestra, Walton 6174
Lion's head, photographed..... *6103
Lithium.....5952
Lithographic ink machine *6186
Liquefaction of oxygen..... 6158
Liquid measurer, Mourgy's.... *6031
Liquid meter, Helbing's..... *5015
Liver fluke, life history *6228
Locomotion, curious vehicles.. *6209
Locomotive, electric, mine.....*6095

Locomotive, tank, improved..*5864
Locomotives, American, early..*5913
Locomotives, Eng. and Amer. 5898
Locomotives for Victoria..... 6044
Locomotives, St. Gothard..... *6120
Logs, ships', electrical *5842
Long-distance speaking *5856
Logwood, extracting apparatus*6304
Longitude 6390
Loom for rubber fabrics *6241
Lumber drier, the Excelsior.. *5981
Lumber, how to season..... *5981
Lumbricus, a new..... 6163
Luminosity of flame..... 6141
Luminosity of magnets..... 6217
Lungs, resections of 5877
Lupuline, chemistry of 5953
Lysiopetalidæ, pores of..... 6103

M

Machinery and tools, remark.. 6185
Machinery, hydraulic..... *5895
Machinery, photo., paint for.. 5842
Machinery, photographing.... 5951
Machinery, the balancing of.. *5897
Magenta in wine, detect..... 6158
Magic cabinets..... *6211
Magic portraits..... *6038
Magnesia, manufacture..... 6158
Magnesium lamp, Loiseau's .. *5982
Magnet controller, Thomson . *6185
Magnets, luminosity of..... 6217
Magnetic balance *6154
Magnetic music teacher *5952
Magnetic station, observatory .*5154
Magnetism *6094
Magnetism and vibration..... *6046
Magnetism, experiment in 6147
Magnetism in iron, cause of... 6216
Magneto and dynamo mach.. 5888
Magneto-sounders *6014
Maiche, Louis *6161
Maison du Saumar, Chartres.. *5884
Malacosteus niger, fish..... *6104
Malaria.
6031, 6052, *6067, *6082, *6096, *6116, *6129, *6145
Malaria plant, analysis of 6147
Malaria, plants cause of *6130, *6151
Malaria, treatment of..... 6118
Malt-mashing machine..... *5839
Malting, fire risks of 6001
Mammalia, extinct, London.... *5956
Manchester ship canal *6107
Man-of-war, New Esmeralda.. *5906
Mansard roof dwelling *6125
Mantels, ornamental..... *5849
Mantis, praying, the *6149
Map of Panama Isthmus..... *5852
Maples, propagation 6195
Marine work, concrete in *6169
Masdevallia, spectral..... *6133
Mash-tuns, false bot om for... *5839
May-flies *6150
Measurer, liquid, Mourey's .. *6021
Measures in Turkey, new..... 6085
Measurements, photometric 5977
Measuring appar., electr. light*6170
Meats, canned 6148
Medical use of music..... 6002
Memorial, Victor Emanuel *5993
Mental disease, cephal. auscult 6083
Menthol crystals, Japanese .. 5859
Menthol versus pain..... 6179
Mersey railway tunnel..... 6120
Meshrebiyehs, Caffene..... *6098
Meter for elect. currents, new *6579
Meter, liquid, Helbing's..... *5915
Metal, new, zircon 6214
Metals, action of glycerine .. 6223
Metals, extract'n by electrolys 6 16
Meteorology, photography in.. 6221
Mewzicst polifolia *6034
Micrography, photo *6030
Miasm, marsh, notes on..... 6147
Mice, field, extirpation..... 6234
Microphone, action of *5843, *6027, *6111
Microphonic contacts *5895
Microphone, sounds, re-enf.. *6172
Micro-telephone, D'Arsonval's*5906
Milk, analysis of *6016
Milk, benzoic and boric acid in 6051
Milk, mother's, artificial 5974
Milk, skim, nutr. value 6022
Milk, soda in 6095
Mill, oil, machinery *5907
Mill, porcelain cylinder *6007
Milk secretion, changes in 6224
Mills, explosion in..... 5970
Mills, wind, origin of *6044
Millefleurs, ess., formula..... 6067
Millstone dress, model *5883
Mine, Calumet, standpipe *5915
Mine, coal, electr. locomotive .*6235
Mine, coal, deepest American. 6061
Mines, appar. for descend into.*5854
Mines of old Mexico 6214
Mines, quicksilver, Calif..... 5988
Mines, whim for *6076
Mineral localities new 5910
Mineral springs, Virginia.... 5833
Mineral waste, utilization.... 5921
Mining, gold, electricity in.... 6093
Mirror, toilet, in silver..... *6175
Mississippi lands, sale of 6212
Mississippi, old, tributaries... 6133
Mite, currant bud *5891
Models, new material for..... 6029
Model of octopus *6213
Molasses, beet root, app..... *5936
Mollusca *5925
Monster, the Gila *6197
Moon, phenomena for 1883.. 6054
Morris Canal, inclined planes.. *5943
Moth, parsnip seed *5891
Moths disseminated by cars... 6104
Motor, oscillating, for pump .. *5997
Motors, gas and steam, effic'y.. 5864
Mould, prevention of 5878
Moving of large masses..... *5853
Mulberry barks 5921
Mullein leaves in phthisis..... 6179
Mummy garlands, flowers of.. 5973
Muscardine 6052
Muscle grafting 5877
Muscle vs. brain 6226
Museum, Amer., Nat. History. 6004
Museum, Commerc., Brussels. 5898
Music in Japan 6069
Music, medical use 6002
Music teacher, magnetic..... *5952
Mule spindle, duplex..... *6049
Musk 6242
Mysterious wells..... 6038

N

Nail makers in Black Country. 5993
Naphthalin..... 5877
Naphthalin as wound dressing 5938
Naphthol, testing for..... 5937
Nasique, the (snake)..... *6226
Nasmyth James..... 6060
Natural History, Amer. Mus.. 6004
Navigation, aerial 5933
Needle, dipping, discovery of.. *5843
Negatives, gel. emuls., devel .. 6149
Negatives, gelatine, washing.. 6078
Negatives, reversed 5951
New Esmeralda, war ship *5906
New Jersey, geolog. report 6166
New York terminus N. Y. W. S. *6073
Nickel cofnage 5874
Nickel from cobalt, separation 6209
Nitric and chrom acid batteries 6089
Nitrogen, liquefaction..... 6158
Nitro-glycerine and gun cotton 6064
Nitro-glycerine into glycerine. 6191
Nitro-glycerine, properties.... 6051
Nomodont curve, the *5903
Nose ape, the *6213

O

Oats, exciting property..... 6182
Obesity, remedy for 5846
Observatory, St. Maur Park... *6154
Octopus, giant, of America... *6213
Oil, bottle-nosed whale 5922
Oil, cod-liver, value 6193
Oil mill machinery *5907
Oil, olive, adulteration of..... 5876
Oil on troubled waters 5955
Oil peppermint, Japanese..... 5859
Oil well, boring..... 6185
Oils, essential, adulteration .. 5852
Oils essential, patent 5908
Opal printing, emulsion for... 5859
Ophthalmometer, new *6115
Ophthalmometry and astigmat. *6114
Opium in Africa 5973
Orange tree scale 5910
Orchid, Masdevallia chimæra.. *6133
Ore separator, new 6075
Ores, iron, crystalline, origin.. 6036
Oregon, steamer 6185
Organ, Temple Church, specifi. 5903
Organic forms, artific. produc. 5903
Organic subst. sens. to light... 5985
Organisms in build. material. *6182
Ottawa River dam *6121
Ovens, bread, improved *5916
Oxalic acid 6209
Oxygen from dialysis of air... *5859
Oxygen from potassium chlor. 6063
Oxygen, influence on blood.... 6177
Oxygen, insensi. from want of. 6159
Oxygen liquefaction 6158

P

Pacha, the decapitated..... *5990
Paille-en-queue, home of..... *6104
Pain, menthol versus..... 6179
Paint, blistering 6175
Paint. photog'h. for machines. 5944
Painting the Brooklyn bridge. 6044
Palace of Fine Arts, Rome ... *6013
Palazzo Vendramin-Calergi .. *6077
Palm, a marvelous 5925
Panama Canal, line of..... *5853
Panama Canal, progress..... 6100
Panama, Isthmus, map..... *5852
Pantheon, the *6135
Panax victoriæ *6148
Paper steam launch..... 6235
Paper, a history of *5965
Paper, incombustible *5932
Paper, photograph, treatment. *5866
Paraffin, amorphous *6051
Parsnip seed moth..... *5891
Parsonage, design for *6300
Paris, surface temperatures... *5908
Passiflora, Prof. Eichler..... *6180
Pasteur on rabies..... *5923
Patchouli, ess., recipe..... 6067
Patent essential oils *5908
Pea-nut, the *5845
Peat or black earth 5877
Peppermint, Japanese..... 5198
Peppermint oil, Japanese..... 5859
Perfumes, formulæ for..... 6067
Pernettyas..... *5957
Pests of the garden..... *5891
Pestilences and plagues..... 5906
Petroleum and its products .. 6159
Petroleum res., anthracene fr. 6009
Phenacite, locality for..... 6010
Phenacodus, the genus..... *6213
Phosphorescent tablet, light.. 5969
Photo-electric battery, new ... 5960
Photo-engraving, improved.. 5842
Photo light equalizer *6000
Photo-micrography *6100
Photomicrography *6238
Photo plates, manufacture ... 5951
Photo plates, wet and dry.... 6189
Photo-printing..... 6095
Photographic action, study of. 6239
Photograph paper, treatment . 5886
Photographic paint..... 5842
Photographic residue, working*6013
Photographing machinery.... 5951
Photographing solar corona.... 5930
Photography, enamel 6094
Photography in meteorology.. 6223
Photography, instant., specim.*6108
Photography, solar..... 6157
Photometer, electric light 6170
Photometer, Pentane..... *6047
Photometric measurements 5907
Photometry of the sun, etc.. *6047
Phthisis, forced feeding in.... 5890
Physical exercise 5890
Physics, atomic, problem in .. 5955
Physics without appara tus... *6191
Pianoforte, history of..... *6142
Picardie, steamer, shipwreck .*6023
Piers in the Atchafalaya..... *6166
Piesse, G. W. Septimus *5944
Pictures in glass *5904
Pictures on glass..... 6129
Pigment, new, uro-roseine 5903
Pigments, bile, reactions..... 5910
Pile, chloride of silver..... *6141
Pills, coating with gelatin.... 5939
Pitch lake, Trinidad..... 6105
Pitcher plants 6227
Plagues and pestilences 5906
Planets, phenomena, 1883.... 6054
Plant fibers, analysis of..... 6017
Plant-knowledge, progress.... 6180
Plants, effect electric light 6036
Plants found in malarial urine*6097
Plants from ague-bogs..... *6082
Plants in fever urine..... *6116
Plants, malaria, synopsis 6131
Plants, malaria, *6082, *6093, *6096, *6 97, *6116, *6130, *6131
Planting in waste places..... *5925
Plates, gelatine, coating..... *5887
Plates, gelatine, developer.... 5858
Plates, gelatine, development. 5842
Plates, gelatine, enlarge'ts on. 5959
Plates, gelatine, intensify 6013, 6096
Plates, gelatine, preparation .. 6128
Plates, photo, manufacture.... 5951
Plates, photo, wet and dry 6189
Plates, wet, intensifier for.... 6189
Platinum, photog. recovery... *6013
Plowing engine, steam, impd. *5864
Pneumonia 6018, 6192
Pneumonia, prevention 6176
Poison of scorpions..... 6103
Poison, rattlesnake..... 6034
Poison, rattlesnake, antidote.. 6210
Poi-oming, rhus, sassafras in .. 5938
Polar auroras, theories about.. *5927
Polarimeter, new, Laurent's.. *5962
Polarized molecules, rotation.. 6216
Pompeii, victims of 5989
Pompeiian surgery *5935
Popocatepetl, ascent of 6210
Poppy cultivation, Macedonia. 6180
Population of Alaska..... 5818
Porcelain cylinder mill..... *6007
Pores of Lysiopetalidæ 6103
Port Lyttleton, N. Zealand... *6167
Portfolio, magic..... *6211
Portland cement, manufacture 6155
Portraits, magic 6038
Post office, world as relat. to . 5990
Potash, bichro., st'ns remov. 5936
Potash for barren fruit trees .. 6226
Potassium chlor., oxy. from... 6063
Potassium oxalate, recovery.. *6013
Potassium, nit., in pota. cult.. 6096
Potato bug, medical prop..... 5890
Potatoes, early, getting ready. 6033
Potatoes, potass. nit., manure 6086
Pottery, enameled, Luca's.... 5905
Poultry and egg trade 5954
Poultry raising, profits..... 5954
Power, electric distribu..... 6109
Press, continuous, beet-sugar. *5979
Press, filter, laboratory..... *6238
Press, hay, Pilter's. *5911
Press, hydraulic, how made... *5859
Press, hydraulic, new *6170
Pressure app. for water mains.*5931
Primer for pumps *6044
Printing, calico, sulphocy in.. 6113
Printing, opal, emulsion for... 5859
Printing, photo 6095
Problem in aromic physics.... 5855
Projecting lanterns..... 6237
Propeller, screw, the *5898
Prussic acid in cassava 6051
Puddling, iron, progress 6185
Pullman train, Calais to Rome. 6107
Pump, motor for *5997
Pumps, primer for *6044
Pumping station, Boston..... *6025
Puppet shows, Grecian..... *6137
Pylorus, resection of 5877
Pyrogallic developm't plates.. 5843

Q

Quadrant electrometer..... *6014
Quartz crystals, explosion 5924
Quicksilver, California..... 5942
Quicksilver mines, Cal., geol.. 5988
Quinine, the trade in 5986

R

Rabies, Pasteur on..... 5923
Radiation, terrestrial..... 6093
Rafts, life..... 6102
Rags, carbonizing, apparatus *6029
Radiation of cold, apparent... 5908
Rail and wheel for roads *6011
Rail mill engines, improved.. *6235
Rails, steel, 150 ft. long 6184
Railing, iron, ornamental.... *6113
Railroad construction, recent. 5949
Railroad, N. Y. & W. S., term. *6073
Railroad trains, fastest..... 5848
Railroads, American, early.... 5912
Railway car, dynamometric.... 5880
Railway, cable, Chicago..... *5860
Railway bridge, St. Leger Val. *6008
Railway bridge, Indus *6071
Railway bridge, Kinzua..... *5880
Railway, electric, Portrush... 6187
Railway, electric, subterr'ean. *6025
Railway train, derailment of.. *5834
Railway trains, indicator..... *6057
Railway tunnel, Mersey..... 6120
Raphael celebration, Rome... *6135
Raphael, tomb of *6136
Rat, where welcomed..... 5954
Rattlesnake poison..... 6054
Rattlesnake poison antidote... 6210
Rays, wave-length, meas'm't.. 6158
Reactions, chem., gum ara. in. 5844
Receiver, telephone, new. ... *6063
Recorder, sunshine, new..... *5887
Records, horse, fastest 5972
Rectory, design for..... *6200
Red, Turkey 6222
Reflection, electric, illum. by 6047
Registering appar., Richard's *6042
Regulator, current, Thomson *6188
Reliefs, Woodbury..... 6222
Remedies for headache..... 6118
Report of geologist, N J..... 6166
Rescue of crew, Heard Island. *6020
Reservoir, cement..... *6186
Resin, products of distilla.... 6095
Resistance meas., elec. light.. 6171
Respiration, mechanism of 6177
Rheolyzer, invention of 5887
Rheostat, De Combettes's.... *6229
Rhus poisoning, sassafras in .. 5938
Ribbon stretching machine .. *6305
Rig, new, for steamers..... *6068
Rigs for war ships, Forbes'.. *6232
Rings, seamless, machine..... *5914
River Plate, fireproof towns .. *6200
Roads, macadam., harrow for.*6075
Rock, a large, removal of *5853
Rock drill, Welker's..... *5882
Rocks, gold bearing, Austra .. 5924
Rolling mill, engines, improv.. *6235
Rondeletia, ess., recipe..... 6067
Rose Gloire de Dijon 5926
Rose, white, ess., recipe..... 6 67
Rouser and aerator, Cave's.. *5899
Royal Courts of Justice..... *5870
Rubber fabrics, elastic, app.. *6221
Rudders, cast-steel *5977
Rupert's drops..... 5953

S

Saccharimetry, polarimeter for*5962
Saccharuric comp'd, note on.. 6017
Safety-apparatus for boilers ... *5975
Safety appliances in buildings.. 5989
Said I to mys lf..... 6053
Sand movement, study *6033
Sanitary appliances, house... *5883
Sap, a note on..... 6148
Sassafras in rhus poisoning 5938
Saturator, cascade *5931
Scale in boilers, prevention.. 5976
Scale on fruit-trees, remedy... 5910
Scale, orange-tree..... 5910
Scales, bagging, Paupier's. ... *5855
School, grammar, Heath..... *6092
School horograph, Matthey's. *5949
School, new, City of London.. *5834
Schooled, but not educated.... 6054
Science against darkness..... 6099
Scientific exhibitions *6211
Scientific service, our..... 5991
Scientific shows *6230
Science, side show *6109
Scorpions, poison of 6103
Screw-cutting gap lathe..... *5978
Screw-propeller, the *5890
Sea-water, calmed by oil..... 5955
Seeds, effect of air on..... 5958
Separator, ore, new *6075
Separators, grain Marot's .. *6190
Sewage and sewerages..... *6304
Sewage, disposal for houses... 6173
Sewage process, a new..... 5859
Sewage, improved, Boston *6025
Sewers, Paris, elec. light in... *6153
Shaw, Capt. Eyre Massey..... *6084
Ship building, iron 6185
Ship canal, Manchester *6107
Ships of war, rigs, Forbes' .. *6232
Ship, war, New Esmeralda..... *5906
Ships, electric light on 6189
Ships' logs, electricity applied*5842
Ships, stall'g indicator *6140
Shipwreck of str. Picardie.... *6023
Shoes at Museum of Cluny ... *6229
Shows, puppet, Grecian..... *6137
Siemens-Martin, steel process. 6184
Silos and ensilage 6033
Silver, chloride, pile *6141
Silver iodide in gelat. emuls.. 5842
Silver nitrate, poisonous prop. 6145
Silver, photog., recovery..... *6013
Silverware manufacture..... 5920
Sirup of corn silk *6210
Sizing, fire risks of 6001
Sizing machine, improved *5851
Skeleton of Raphael *6135
Skeleton of whale, fossil..... 6101
Sheep, winter, of animals..... 5940
Slag, the cellar..... *5925
Slugs and snails *5925
Sluice gates, floating dock.... *5995
Smelting works, Belvue, Idaho.*5881
Smilax tamnoides..... *5942
Snail, winter sleep of 5940
Snake bird, the 6103
Snake, lignified, of Brazil..... 5941
Soap, analysis of 5967
Soap, glycerine..... 6224
Soap, palmate of lime..... 6223
Soda, acetate, new uses..... 6158
Soda in milk..... 6095
Soil, alluvial, and cancer..... 5954
Soil, bacteria in the..... 5986
Soils, Japanese 5892
Solar corona, photographing.. 5930
Solar photography..... 6157
Solar spots, theory of 5892
Solenoid galvano'ter, Blyth's .*6306
Solidification of carbon sulph. 6153
Somerville Hall, Oxford *5991
Sounds, telephone, re-enfor't . *6172
Sounders, magneto..... 6014
Sounders, telegraph, Bright's. *5935
Spark, induct'n, therm. phen.. 5962
Spathiphyllum hybridum *6180
Speaking, long distance..... *5856
Speaking without wires..... *5856
Speech in animals 5940
Spherical, the Thomson..... *6188
Spider red *6196
Spindle, mule duplex..... *5949
Spiræa flagelliformis..... *6003
Spleen, removal of 5877
Spottiswoode, William..... *6190
Spur wheel teeth, llm. number*5901
Sputa, tubercle bacilli in..... 6145
Stability indicator, ship..... *6140
Stage allegory, a 6009
Stakes, slope, setting..... *5881
Stamping ink, indelible..... 5953
Stand for telescopes..... *5974
Stand pipe, Calumet mine..... *5915
Starch..... *6241
Starch, soluble 6064
Starch sugar, refining..... 5995
Statue, marvelous, Cybele *6137
Statue of Columbus, new *5847
Steam and gas motors, effic'y . 5864
Steam boilers, safety apparat.. *5975
Steam cultivator, new..... *5963
Steam engine, origin of..... *6087
Steam fire engine, English.... *5914
Steam launch, paper..... 6235
Steam, superheated 5932
Steamer Austral, sinking *5933
Steamer, Channel, launch of.. 5898
Steamer La Plata, rudder..... *5977
Steamer, new, La Normandie. *5831
Steamer Oregon..... 6185
Steamer Picardie, shipwreck.. *6023
Steamers, new rig for..... *6068
Steamships, ocean, swift..... 6204
Steamship Violet..... *6152
Steel and iron..... 6184
Steel and iron process, Bull's . 6058
Steel, basic 6184
Steel, Bessemer, progress 6184
Steel, magnetism, cause..... 6216
Steel plant, the, of future 5990
Steel, protection from rust 5931
Steel, tempered, rigidity 5976
Stern frames, cast steel *5977
St. Gothard locomotives *6120
Sties, a cure for..... 6182
St. Leger Valley, rail'y bridge.*6008
St. Nazaire floating dock *5995
Stoker mechanical, Sinclair's.*5979
Stone age in Oregon..... 6037
Stones, building, decay of..... 5964
Stoneware, about 6113
Stoppers, glass, removal 5938
Storage batteries..... 6171
Storage batteries, Edison on .. 5999
Storage, electrical 6127
Storms, wind, angular motion. 6208
St. Paul's cathedral *5995
Strawberry, the Alpine..... *5845
Straw plaiting in Tuscany 5906
Stretching machine, ribbon *6305
Stroh's experments ..*6046, *6205
Strontianite, production..... 5844
Suez canal 6073
Sugar, starch, refining..... 5965
Sugar works, press for..... *5979
Sugaring, natural..... *6070
Sulphocyan'des in cal. print.. 6113
Sulphur in Italy 6022
Sulphur, zinc on..... 5937
Sulphuric acid apparatus..... *6051
Sun, travels of the..... 6195
Sunflower, the 6008
Sun phenomena for 1883 6054
Sun, photometry of..... *6047
Sunshine recorder, new..... *5887
Surgeons, German, congress of 5877
Survey, Pompeiian..... 5995
Survey of the Black Cañon.... 6133
Suspension br'e, Monongahela 6201
Suture-clamp coaptation *6213
Swallows, settling 6165
Swallow, the, new vehicle *6185
Sweet gum tree 6105
Swine, breeding and manage.. 6181
Synthesis of uric acid..... 6051

T

Table, autopsy, new *6132
Tannin in bark U. S. trees 6001
Tape stretching machine..... *6235
Tapestry, Egyptian *6098
Tavern, coffee, Newark, Eng.. *5841
Teeth, spur-wheel, llm. numb *5901
Telegraph apparat., chemical.. *5858
Telegraph, Buckoltz's..... 6013
Telegraph, electric, history .. *6125
Telegraph, Lesage's. *6136
Telegraph office, elect. light'g *5919
Telegraph, Ronald's..... *6127
Telegraph sounders, Bright's. *5935
Telegraphs, optical 6014
Telegraphy, automatic..... *5858
Telegraphy, field, without batt. 6013
Telephon, das..... 5905
Telephone, Goloubitzky's..... *5918
Telephone, Husband's..... *6027
Telephone, interfer. of so'd by.*6068
Telephone, Kotyra's..... *5918
Telephone, m'o., D'Arsonval's.*5906
Telephone, Pollard's *6172
Telephone, Reis'..... *6247
Telephone receiver, new..... *6 53
Telephone sounds, re-enforce. *6172
Telephone transmitters, new.. *6110
Telephonic sounders, systems. *6014
Telephonic translators *5951
Telephony, long distance *5951
Telescope, small, stand for .. *5974
Tellurium in copper..... 6022
Temperatures, low, production 5908
Temperatures, surface, Paris.. 5908
Temple, Roman, Pantheon.. *6135
Temporal bone, resection..... 5877
Tendons of whales..... 6101
Tentering machines, clip for.. *5884
Terrestrial radiation 6093
Test for albumen, delicate.... 5859
Thermometer, registering *6043
Thomsenolite, locality 5910
Thoracic viscera, operation on 5877
Three headed woman, trick ... *5939
Timber, eucalyptus, value 6095
Time taken by stellar obs..... 6028
Tincture of corn silk 6210
Tissue, flexible, for windows 5986
Toilet mirror in silver..... *6175
Tomatoes, a trial of..... 5958
Tomb of Raphael *6136
Tools and machinery, remark. 6185
Tools, hydraulic machine 6088
Torpedo boats..... *6139
Torpedo system, McEvoy's.. *6215
Torpedoes, mode of firing.... *6139
Topaz, locality for 5910
Totalizing integrator..... *5869
Towns, fireproof, River Plate. 6200
Trailer, a graceful *5942
Train, Pullman, Calais to Rome 6107
Trains, passage, indicator for. *6057
Trains, railroad, fastest..... 5848
Tram car, electric, new *6092
Tramways, electricity on *6092
Tramway, elect., Portrush, cost. 6206
Transmission, electrical..... 6127
Transmitters, telephone, new . *6110
Transparencies, lantern., carb.. 6113
Transportation, barge, lake .. 6023
Transit of Venus, Cuba..... *6036
Transit of Venus, the..... 6035
Travels of the sun 6195
Treading cask for leather..... *5870
Tree, sweet gum 6105
Tree, eucalyptus, the 6095
Trees, forest, Canada, limit.. *6238
Trees, old and remark., pres.. 6094
Trees, maple, propagation..... 6195
Trees, U. S., tannin in bark .. 6001
Trepanning doub ident. after 6230
Trevithick, Richard 5917, 6061
Trial-bell, galvanometric..... *6179
Tricycle, electric *6207
Tropic bird, home of..... *6104
Trotter, Amer., evolution..... 5998
Trotters, winning, statistics.. 6090
Trotting statistics..... 6090
Tubercle bacilli in sputa..... 6145
Tunnel bet. France and Eng... 5963
Tunnel, Mersey 5948
Tunnel, railway, Mersey..... 6120
Tunnel, Severn 5948
Tunnel, St. Gothard, locomot *6120
Tunnel under the Elba *6097
Tunneling mach., Crompton's *6044
Turbines for small industries.. *6094
Turkey red..... 6222
Turkeys, Amer., for Europe... 5964
Typhoid fever, curability..... 6007

U

Underground system, electric.*6219
Uric acid, synthesis 6051
Urine, ague, crystals in..... *6117
Urine, fever, plants in..... *6116
Uro-roseine, pigment 5903

V

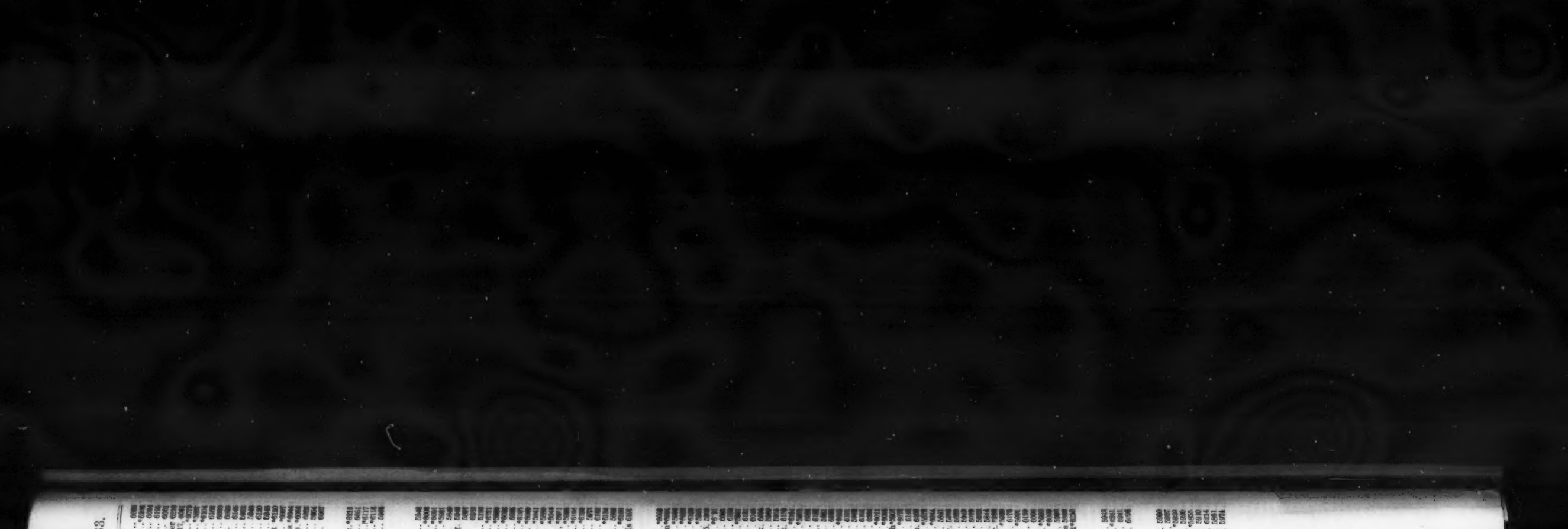
Viaduct, Kinzua 5940
Viaduct, St Leger Valley..... *6008
Vacuum, influ. on electricity.. 6091
Valve, ball, improved 5985
Vanadium green 5940
Vegetables, canned, greening. 5940
Vegetable waste, utilization.. 5997
Ventilation, coal gas in 6222
Ventilation, discoveries in.... 6188
Ventilating air compresser .. *6231
Ventilator, the Kosmos..... *5980
Venus, transit, Cuba *6036
Venus, transit of 6035
Vehicle, new, the Swallow..... *6185
Vehicles of locomo., curious.. *6240
Vertical engine, Farcot's..... *5961
Viaduct, Kinzua *5880
Vibrations and magnetism *6046
Vibrations in bridges.. 6071, *6091
Victor Emanuel memorial..... *5993
Victoria regia, building for.... *6184
Villa, design for..... *6190
Vines, American, in France... 5971
Vineyards of California..... 6188
Violet, steamship *6130
Virginia, Southwestern..... 5833
Voice, the mysterious *6150
Volcanic phenom., Hawaiian Is 6101

W

Wagner, Richard *6093
Warehousing machinery, grain *6091
War ship, New Esmeralda *5906
War ships, rigs for, Forbes'.. *6232
Wasps and hornets *6150
Waste places, planting in..... *5925
Waste, utilization of 5895, 5921
Waste water absorber..... *6 91
Watch trade, Swiss..... 6095
Water, color of 6222
Water conduits, regulat. app.. *5995
Water, Croton, organisms in.. 6091
Water gas as fuel 6040
Water, geyser, Yellowst. Park. 6090
Water works, Antwerp 5995
Waters, troubled, oil on 5955
Wave length rays, meas'ment. 6179
Weeping blue juniper..... *6204
Weighing machine for zinc.... *5995
Weights in Turkey, new..... 6085
Well, oil, boring..... 6185
Wells, artesian, Australian.... 5995
Wells, mysterious 6038
Weser River lighthouse..... *6093
Whale skeleton, fossil 6101
Whalebone 5964
Whales, tendons of 6101
Wheat, analysis..... 6222
Wheel and rails for roads..... *6011
Wheels, turbine, small *6093
Wheels, spur, llm'g num. teeth *5901
Whim, compressed air..... *6076
Wine, adult., detection..... 6149
Wind storms, angular motion. 6208
Windmill churn..... *5870
Windmills, origin of *6044
Window-glass, manufacture .. 5961
Wind's, dark room, tissue for. 5959
Winners, big (horses)..... 6090
Winter sleep of animals..... 5940
Wire, grit, preparation..... 6029
Wire, rigging, old, use..... 5925
Witherite, artific production. 5844
Woman, civilized, etc., in labor. *6093
Woman, three headed..... *5939
Woman, diseases, prevention. 6170
Women students, hall for..... *5998
Wood, cucumber 6199
Wooden vessels, bad taste in. 6006
Woodlands, the, near Leeds... *5995
Woolen, separation, app *6093
World as related to post office. 5990
Wound dressing, naphthal. as 5998
Wounds, closing, new method*6230

Y

Yak, acclimation of..... 5949
Yeast fungi *6091
Yeast, operation of..... 6091
Yellowst, Park geyser water .. 6090

Z

Zinc industry of the West..... 5990
Zinc on sulphur 5987
Zinc, refining, apparatus..... *5930
Zinc, use and manufacture 5939
Zinc, weighing, machine for *5855
Zircon, locality, new 6035
Zircon, new metal..... 6214
Zoölogy, comparat., lesson in. 5881
Zunis, home of..... 5974